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Forthcoming Events.

FEBRUARY 9.

British Foundrymen's Association: Scottish Branch:—"Carbon in Cast Iron," by Dr. C. H. Desch.

FEBRUARY 23.

British Foundrymen's Association: Newcastle Branch:—"Necessity of a Government Information Bureau for Foundrymen," by R. Buchanan, F.R.S.

British Foundrymen's Association: East Midlands Branch:—"The Training of Apprentices," by H. Schofield, B.Sc.

British Foundrymen's Association: Birmingham Branch (joint meeting with Staffs. Iron and Steel Institute):—"Design and Production of Steel Castings," by J. E. Fletcher.

MARCH 2.

British Foundrymen's Association: Scottish Branch:—"Special Irons," by J. Donaldson, B.Sc.

MARCH 13-14.

Institute of Metals:—Annual meeting, Burlington House, W.1.

NOTES AND COMMENTS.

Association of Metallurgical Chemists.

The position of the metallurgical chemist operating in connection with iron and steel and non-ferrous works has in the past been so indefinite, and yet so important, that we cannot but welcome the formation of the Sheffield Association of Metallurgical Chemists, particulars of which are published on another page. The Association, which is working in complete sympathy with the British Association of Chemists, is designed to take care of the properly-trained man who is so essential to industrial progress, and to assist the efficient application of science to industry. Metallurgical progress has suffered considerably in the past by reason of all laboratory workers being classed indiscriminately as chemists. It is not yet sufficiently appreciated, even by the firms employing them, that there are essentially two types of workers in metallurgical chemistry, one the untrained or routine man, whose chief duties are to carry out mechanically the processes of the work, and the other who is required to be a properly-trained man capable of directing such work. The distinction is particularly marked when new research work is in hand. Nevertheless, the importance of the chemist has been brought into question, and the profession somewhat discredited in the eyes of many employers, through the attempt to obtain the effects and advantages of a highly-trained man's services from an untrained or poorly-trained routine laboratory worker operating for a mere pittance in place of an adequate salary. It is not the crucible and retort of the laboratory that make the magician; but the knowledge and intelligence behind operations which anyone of slight mechanical skill can perform. It is, of course, understood that between the two extreme classes mentioned are workers more or less qualified to be considered trained men, and it is almost impossible to set a line of demarcation, however marked may be the difference between the two extremes. This applies more or less to all professions; and while the formation of such associations as the above cannot alter the fact, a proper selection in permitting membership can do much to bring home to employers the distinction between the highly-trained and the man who is only partially trained.

The activities of technical societies can have two main directions: one the creation of increased prestage for the profession and the differentiation of skilled and unskilled; the other, the dissemination of information among the members for the technical advancement of the calling. With reference to the latter, we note with interest that the new Association proposes to hold weekly meetings on club lines, which will allow a very desirable intimacy between members for their mutual benefit, We trust, however, that the activities of the new Association will not clash with the good work already done by the Sheffield Society of Engineers and Metallurgists.

Protected Occupations.

The Ministry of National Service has issued a revised Schedule of Protected Occupations for men employed on Admiralty, War Office and Munitions Work or in Railway Workshops. It is numbered M.M. 130 (revised) and dated February 1, 1918, and indicates the changes in the previous Schedule, under which certain men are to be recruited for the Army from the protected trades. Opposite each occupation is set the age at which protection begins. The ages relate to the date, January 1, 1917, so that a man who has reached the stated age since January 1, 1917, is liable to recruitment. It is important also to note that the Schedule does not, of course, enumerate anything like all the occupations which are to be found in munitions work. All men of military age engaged in an occupation not scheduled are liable to recruitment if they have been medically classified Grade I (*i.e.*, fit for General Service).

The country has been divided into special Munitions Recruiting Areas, in which there are offices where representatives of the Ministry of Munitions and of the Recruiting Department of the Ministry of National Service are located. These offices are also in touch with local representatives of the Admiralty, with the War Office Contracts Department, and with the local Employment Exchange. Each office is responsible for issuing to workmen in firms in its area engaged on the manufacture of munitions of war, certificates of protection from military service; the Scheduled Occupation certificate (generally known as the "red card") to men whose occupation is scheduled, and who are above the age limit or below Grade I, and the temporary protection certificate (known as the "black card") to workmen not in a Scheduled Occupation who are below Grade I. If a workman receives a black card and considers that he is entitled to a red card, or if he is called up and considers that he is entitled to a red card, he can lodge a claim with the Enlistment Complaints Subcommittee at the office for his area.

The Scheduled Occupation certificate and the protection certificate are not certificates of exemption under the Military Service Act. They are certificates issued by the Recruiting Authority to show that the Authority has decided not to call up the holder for the present. They can only be recalled at the instance of the Munitions Area Recruiting Officer, who only calls up those men whose names are passed to him by the local representative of the Admiralty, War Office (Contracts), or Ministry of Munitions, as the case may be. The Departments responsible for supply are thus also responsible for deciding, subject to the provisions of the Schedule, which men are to be recruited.

The main features of the revised Schedule which came into force on February 1, 1918, are as follows:—

(1) As at present only men medically classified Grade I, *i.e.*, fit for general service, will be recruited.

(2) With the exception of certain classes of men engaged on urgent Admiralty work, the minimum age of protection for Grade I men is 24.

(3) Under the Schedule hitherto in force, men have not been recruited from Admiralty, War Office, or Munitions work if they were over the age of 32. They are now liable to recruitment up to the full military age unless they are in a Scheduled Occupation where some lower age limit is fixed.

(4) The Trade Union representatives have pressed upon the Government that "dilutees" should not be retained while skilled men are recruited. The revised Schedule provides for the release of dilutees, if of Grade I, to a far greater extent than heretofore. This is secured by the provision that a man is not entitled to claim a Scheduled Occupation Certificate unless he can show that he was in a Scheduled Occupation (not necessarily with the same employer) on or before August 15, 1915.

(5) The men now rendered liable for recruitment from munitions work are thus of three classes:—(*a*) In all but a few occupations, men under 24, if Grade I; (*b*) in some occupations, men over 24, if Grade I; (*c*) "Dilutees," if Grade I, *i.e.*, men who have entered their present occupations since August 15, 1915. These classes of men will be recruited concurrently.

It will be noted that the Schedule of Protected Occupations is a different document from the List of Certified Occupations, issued for the guidance of Tribunals. The right of a man to apply to the local Tribunal on *personal* grounds under the regulations and instructions for the time being in force is not affected.

The following trades are included in the Schedule:—

Iron and Steel Manufacture (not Foundry).—All classes of workers (except unskilled men) engaged in the manufacture of iron and steel, from the treatment of the ore to and including the production of the metal in standard forms such as ingot, billet, bloom, bar, rod, plate, or section, but excluding all workers engaged in the manufacture of steel sheet, tinplate, blackplate, or terneplate (23).

Other Metals.—An Age Limit of 23 is fixed for all classes of workers (except unskilled men) engaged in the manufacture of the following metals, from the treatment of the ore to and including the production of the metal in standard forms such as ingot, bar, rod, plate, sheet, section or powder:—Copper, spelter and zinc, aluminium, lead, nickel, tin (smelting only), tungsten, bismuth, cadmium, platinum, antimony, manganese, molybdenum, vanadium, alloys of the above metals, other metals needed for Admiralty, War Office or Munition Work.

Foundry Workers.—Coremaker, making heavy or intricate cores only (23), crucible man (25), cupola man (leading hand) (25), cupola charger (28), metal carrier (molten metal) (28), metal caster (strip or ingot caster) (25), metal caster's helper (strip or ingot caster's helper) (28), metal pourer (foundry) (28), metal moulder (excluding plate, machine and rain-water goods moulder (23), plate or machine moulder (28), metal smelter (25), dresser, fettler, or trimmer (all metals), die caster (leading man of squad) (28).

Other Workers.—Annealer (leading hand (28), case hardener (leading hand) (28), gas-producer man (charge hand) (28), pattern maker (23), saw doctor, saw sharpener and setter (hand worker) (28), welder or cutter (oxy-hydrogen, oxy-acetylene, electric) (25), metal pattern filer (32).

File Manufacture.—Foreman (32), file cutter (hand or machine), file grinder and file hardener (all 28), file forger (25).

Scrap Metal Merchants.—Manager, with 10 years' experience of the trade, scrap metal sorter, ditto, and scrap metal broker, ditto (all 28).

Research on Refractory Materials.

By G. E. Foxwell, F.C.S.

It has recently been announced that a new department has been instituted at Sheffield University, under Professor Fearnsides, to carry out research on refractories. A similar department has also been opened at Leeds University, under Professor Cobb, while valuable work has been done by Dr. Mellor and his assistants at Stoke-on-Trent, by the National Physical Laboratory and other workers. The new department at Sheffield is to undertake work which will in no way overlap that being done at other centres, and will specialise more particularly in the requirements of the coke-oven industry. There is such a wide field for research into the refractories used in the iron and steel industries, and the need for this research is so imperative, that coke ovens have been in some danger of being neglected.

The bricks used in coke ovens are always acid. While it is, of course, well known that silica behaves as an acid at a high temperature, it is not everywhere understood that clay bricks are also acid. "Clay substance" is an alumino-silicic acid. To get a good idea of its chemical composition it may be compared with sulphuric acid:—

$$2xH_2,\ y(Al_2O_3,\ 2SiO_2),\ xO_2 = \text{Clay.}$$
$$H_2,\ (SO_3),\ \tfrac{1}{2}O_2 = \text{Sulphuric acid.}$$

This scheme shows the nature of clay in a general way, but its chemical constitution is very complex, and probably rivals that of the most complex organic compounds. This question of constitution is rendered more difficult by the fact that many complex alumino-silicic acids exist. These do not all behave in the same manner on heating, and according to Mellor (*Trans. Ceramic Soc.*, 16, 80) clays may be divided into four classes, which on heating behave as follows:—

(1) Endothermic reactions at 150 and 500 deg. C., and an exothermic reaction at 900 deg. C.

(2) Endothermic reaction at 500 deg. C., and an exothermic reaction at 900 deg. C.

(3) Endothermic reaction at 150 deg. C., and an exothermic reaction at 900 deg. C.

(4) Endothermic reaction between 700 deg. and 900 deg. C.

On burning bricks made from these clays somewhat different methods might be advisable. The usual method in burning is to work to a temperature-time chart, and arrange that the fireman is to attain a certain temperature at a certain time. To produce the best bricks the heating from atmospheric temperature to 1,000 deg. C. should be slow enough to allow of each reaction taking place in order. To mention only one drawback to improper heating:—If the heating between 600 and 900 deg. C. be too rapid, the carbonaceous matter will not be properly oxidised, and the iron will be subsequently reduced with formation of ferrous silicate. The brick will then be more fusible than it should be. On the other hand, if the temperature rises too slowly, fuel is wasted. In burning the bricks, therefore, due allowance for the various endothermic and exothermic reactions which take place with different clays should be taken into account for the most efficient work. Each clay should be investigated, and suitable precautions taken. This is one line on which research is needed, and which might help to improve the quality of existing bricks.

It has already been mentioned that the bricks used are acid. This has always been the case, and probably originated from the fact that acid materials are readily procurable at a low cost. Seams of fireclay underlie many of the coking coals, and the earliest beehives would probably be built from these clays, without any consideration as to whether this material was the best or not. In the days of beehives this point was of no importance, but to-day every point tending to increased efficiency is important, and it is a matter for research whether basic or neutral bricks could not be prepared which would be so satisfactory and last so much longer as to more than counterbalance the increased cost. Thus magnesia bricks have nearly three times the thermal conductivity of fireclay and silica bricks. A mixture of magnesite and kaolin containing 15 per cent. of magnesite would probably be nearly neutral, and would have a softening point of about Cone 26. This might prove the solution of the salt problem. The author does not recommend this particular mixture, but gives it as an illustration of the kind of research that is required.

Another point to bear in mind is the possibility of the formation of advantageous eutectics. A eutectic may be defined as a mixture of two or more different substances in certain proportions at which there is a break in the melting-point composition curve. This melting-point will usually fall within the range of the melting points of the constituents. Eutectics are definite chemical compounds. It may therefore prove possible to make the whole brick of a eutectic which will form a definite neutral chemical compound, be sufficiently refractory, have a high thermal conductivity, and resist the corrosive action of slags, salt, etc. The eutectic will depend not only on the constituents of the mixture, but also on the proportions present. Thus, a mixture of kaolin and magnesite containing 40 per cent. of magnesite melts at Cone 10. This is the eutectic. If 10 per cent. of magnesite is present the melting point is Cone 28, and if 60 per cent. is present it is Cone 26. Some substances when mixed form more than one eutectic.

The study of brick burning is a study of arrested reactions. On heating the raw clay, no fusion occurs until about 1,000 C is reached. At this point or thereabouts fusion occurs of one or more low melting-point eutectics. These, when melted, act as liquids and dissolve a little of the solid, forming doubtless, in some cases, a mixture of higher melting-point, so that the eutectic solidifies again. As the temperature rises other eutectics and fluxes come into play, and the brick is in this way made into a homogeneous mass. It would appear as though by controlling the temperature the mineralogical composition and refractory qualities of the brick could be controlled to a nicety, providing the materials were sufficiently intimately mixed. A great amount of work is necessary to determine what eutectics are most advantageous, at what stage to stop the heating, etc. This point up to now has been met by pushing the temperature of burning as high as possible. With the materials at present employed, this is probably the best practice, but if a study of eutectic mixtures be made, another view may have to be taken of the matter.

Silica Bricks.—When we turn from clay and

clay-bound bricks to consider the true silica bricks, somewhat different problems present themselves. In the clay brick a continued contraction takes place in use, and one of the great problems of research is to prevent this in a highly aluminous brick. Probably the ultimate solution will be along the lines of eutectics mentioned above. In the silica brick, however, there is not a contraction but an expansion to be dealt with. The prevention of this expansion will be obtained when the inversion from quartz to cristobalite is completed in the brick kiln instead of in the furnace. When quartz is heated above 800 deg. C. it commences to invert into cristobalite. In the best brick-kilns it is only possible to convert about 70-75 per cent. The remaining 25 per cent. is converted in the furnace, and as this is accompanied by a considerable expansion it is naturally bad for the furnace. Apart from this "after-expansion," there is also the true co-efficient of expansion of the material. Of the three forms of silica occurring in silica bricks—viz., tridymite, cristobalite and quartz—tridymite has the lowest co-efficient of expansion. Consequently a brick made of tridymite would stand sudden heating and cooling far better than one made of any other form of silica. Moreover, there would be no after-expansion, and the total expansion on heating up being very small, the tridymite brick would be ideal in every respect. According to Fenner, tridymite at temperatures above 1470 deg. C. reverts to cristobalite. Le Chatalier, however, has probably disproved this observation, and concludes that tridymite is the only form of silica stable at elevated temperatures.

On long-continued burning, cristobalite inverts completely to tridymite; two to three weeks' heating at Cone 15 is probably required. Research is necessary to find some catalyst which would so accelerate this inversion as to make it commercially possible in the brick-kiln.

Le Chatalier has thrown considerable light on silica bricks, and the author cannot do better than conclude with the following translation from an article by him (*Rev. de Met*, 1917, No. 2). This extract shows how cristobalite is formed from quartz; it would probably solve all troubles with silica bricks if a catalyst could be found which would cause the precipitation of tridymite instead of cristobalite.

"This crystallisation (of cristobalite) is not produced by simple cooling, but on the contrary by prolonged heating. The theory of this operation is exactly that which I gave long ago for the setting of hydraulic mortars. Quartz, unstable above 800 deg. C., has a greater solubility in the flux than cristobalite, the form more stable at that temperature. The solution saturated with quartz at a given point allows cristobalite to deposit at once. The solution being no longer saturated with quartz can redissolve a fresh quantity, and in turn allows the more stable variety to crystallise, and so on. This crystallisation at a constant temperature unites the grains of undissolved silica to each other. But this solvent action only affects the very fine grains of silica and a very thin layer on the surface of the larger grains. These latter, nevertheless, finish by being also transformed into crystobalite; this takes place *in situ*, and this transformation is accompanied by an expansion of the grains, resulting in a diminution of density. The crystallisation by dissolution in solvents, on the contrary, does not bring any expansion, because the crystals are deposited in the free spaces."

If a cheap flux could be found which would dissolve cristobalite and allow it to crystallise as tridymite the problem would be solved, provided the action were sufficiently rapid.

The average mineralogical composition of a silica brick after one burning is:—Quartz, 25 per cent.; cristobalite, 70 per cent.; tridymite, 5 per cent. It will be seen from this that the change required is very considerable. The change from cristobalite to tridymite is not accompanied by any noteworthy volume change, as although tridymite has a slightly greater specific volume than cristobalite it has a lower co-efficient of expansion, and these two properties compensate each other to a great extent.

Air Inventions.

Under the direction of Lord Rothermere an Air Inventions Committee has just been set up, and will be in operation immediately. The Committee is:—

Mr. H. Darwin, F.R.S., chairman; Major-General Luck, C.B., C.M.G., vice-chairman; Sir Dugald Clark, Sir Richard Glazebrook, Professor H. L. Callander, Professor C. H. Lees, Professor J. F. Petavel, Mr. L. Bairstow, Lieutenant-Commander Wimperis, R.N.V.R., Major G. L. Taylor, R.F.C., Captain B. M. Jones, R.F.C., Captain A. V. Hill, Munitions Inventions Department; Mr. J. P. Millington, and Mr. F. W. Lanchester.

Communications regarding inventions or ideas should be forwarded to the Committee at 2, Clement's Inn, W.C.2.

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES.—A Technical Paper (No. 137) issued by the U.S. Bureau of Mines contains the results of an investigation instituted by Messrs. H. Kreisinger, F. K. Ovitz, and C. E. Augustine, to determine the conditions governing the process of combustion in the fuel bed in a hand-fired furnace. Among other things these tests indicate that with a 6-in. bed of Pittsburgh or anthracite coal the oxygen is all used up in combustion at a distance of 3 to 4½ in. above the grate. The CO_2 content reaches a maximum of about 15 per cent. at a distance of 2 to 3 in. above the grate, and then decreases until, at the surface of the fuel bed, it is 7 to 10 per cent. At the surface of the fuel bed there is 20 to 32 per cent. of combustible in the gases and practically no oxygen, but the percentage of the combustible in the gases increases rapidly beyond 3 in. above the grate. With 12-in. beds of all three fuels tested and with a 6-in. bed of coke all the oxygen disappears 4½ to 6 in. above the grate. But in all tests there was at the surface of the fuel bed a large percentage of combustible in the gas and no oxygen to burn it, showing that the fuel bed of any hand-fired furnace acts primarily as a gas producer. At the surface of the fuel bed and 1½ in. above it, the gases contained more oxygen, more CO_2, and less combustible than 1½ in. below the surface. This change in the composition of the gases was caused by air reaching the surface of the fuel bed from above, along the interior walls of the furnace. The effect of this downflow of air was much more marked with low rates of combustion than with high rates, because with a high rate the large volume of gases leaving the fuel bed more nearly filled the space above it and prevented the air from flowing down. For complete combustion air must be added over the fuel bed. Forced-draught cannot supply enough air through the level fuel bed to insure complete combustion, and additional air must always be introduced over the fire. The ideal way to supply additional air over the fuel bed is to introduce it as close to the fuel bed and in as large a number of small streams as possible. As a general statement, about one-half of the 15 lbs. of air used to burn 1 lb. of coal in a boiler furnace is supplied through the fuel bed; the other half must be supplied over the fuel bed. A thick fuel bed is undesirable because it increases the tendency of the coal to form troublesome clinker.

The Wedge Optical Pyrometer.

This simple instrument consists of a square brass tube furnished with a small telescope, as shown in our illustration, so arranged that the objective of the telescope focuses the magnified image of the heated body on a movable prism placed inside the tube, and actuated by a rack and pinion. There is a suitable shield provided to prevent exterior light reaching the eye. The prism is made of specially prepared dark glass, so arranged that it cuts off at various temperatures the light emitted by a heated body. In looking, e.g., at an iron bar the temperature of which is about 1,000 deg. C., and then turning the screw, the thicker part of the prism comes gradually into the field of vision, the bar appears gradually a darker and darker colour, till at a given point the colour entirely disappears; this point gives the actual temperature, which is indicated on the scale at the top of the instrument. The first readings will

THE WEDGE OPTICAL PYROMETER.

probably be to within 20 deg., afterwards to 10 deg. or less, which is all that is required in actual practice. The reading will be slightly low if layers of carbonic oxide, carbonic acid gas, or steam, intervene between the instrument and the heated object. In observing the melted metal in a crucible, a good plan is to plunge a tube into the metal, making the observation directly down the tube, the surface being thus protected from the fumes.

It will hardly be necessary to point out that industrial furnaces have rarely a uniform temperature throughout, and consequently a fixed pyrometer can only register the temperature in its immediate neighbourhood, whereas in other parts of the furnace it may vary. With an optical instrument the furnace can be inspected now in one place, now in another, at the discretion of the workman.

The instrument was invented by Messrs. Cochrane & Company, the well-known firm of iron-founders at Middlesbrough, for use in their own works; and, its usefulness having been proved, it is now manufactured for sale under their licence by the Optical Pyrometer Syndicate, of 182-183, Temple Chambers, London, E.C. Each instrument before being sent out is calibrated at the foundry by the inventor.

CAST IRON BEARINGS. — A writer in a recent issue of "Mechanical World," suggests the use of cast iron for bearings in practically every case where copper alloys are now used. In his present shop there are dozens of shafts running in cast-iron bushes up to 3 in. in diameter, and up to 1,000 revolutions per minute, and they give very little trouble—certainly no more than brass. When the comparative costs of copper alloys and cast iron are taken into consideration, it will be seen that considerable economy can be effected by the use of the latter in preference to the former, with no reduction in efficiency. When using cast iron as a bearing material, provision should, of course, be made for renewable bushes, as is usual with brass bearings.

Comparison of Pig-Iron Output for 1916.

Mr. G. C. Lloyd, Secretary of the Statistical Bureau of the Iron and Steel and Allied Trades Federation, returned some nine months ago the output of pig-iron in the United Kingdom in 1916 at 9,047,983 tons. According to Part III. of the General Report on Mines and Quarries just issued, the production of pig-iron in that year, and the quantities of coal and coke used in its manufacture, were as follows:—

County.	Pig-iron made.	Iron ore used, including cinder, etc.	Coal used.	Coke used.
ENGLAND.	Tons.	Tons.	Tons.	Tons.
Cumberland ..	720,123	1,346,720	17,163	942,390
Derby (including Nottingham) ..	498,542	1,524,568	442,200	537,604
Durham	1,033,097	2,420,558	63,602	1,293,627
Lancaster (including Flint) ..	716,983	1,452,251	—	1,046,746
Leicester } Lincoln .. }	533,195	1,846,373	44,135	876,329
Monmouth ..	374,062	780,291	16,413	475,946
Northampton ..	284,520	854,002	61,321	399,941
Salop .. } Stafford, North }	339,431	942,992	92,953	396,364
Stafford, South ..	380,707	891,993	41,105	503,196
Worcester ..	29,595	92,428	4,193	48,539
York, North Riding	2,064,204	5,210,130	159,021	2,441,470
York, West Riding	293,339	845,972	34,145	398,057
Total	7,267,798	18,208,278	976,341	9,360,209
WALES. ..				
Denbigh	45,346	135,201	3,344	58,862
Glamorgan ..	481,463	949,639	43,603	480,683
Total	526,809	1,084,840	46,947	539,545
SCOTLAND.				
Ayr	285,340	599,658	468,481	77,609
Lanark and Stirling	839,522	1,612,780	1,120,774	323,525
Total	1,124,862	2,212,438	1,589,255	401,134
Total in 1916 ..	8,919,469	21,505,556*	2,612,543	10,300,888
Total in 1915 .	8,723,560	21,706,411†	2,509,456	9,746,743

* Including 138,269 tons of forge and mill cinder, steel turnings, scale, etc.

† Including 36,250 tons of forge and mill cinder, steel turnings, scale, etc.

The value of the 8,919,469 tons of pig-iron obtained from British and foreign ores in 1916 would be, according to the average export value for the year, £72,368,210, of which 4,319,096 tons, valued at £35,045,211, are due to pig-iron from British ore. Of the 8,919,469 tons of pig-iron obtained, 918,158 tons were exported, leaving 8,001,311 tons available for home consumption. The average prices per ton of pig-iron during the year 1916 were:—Cleveland No. 3, quarterly ascertained prices £4 2s. 10d., quoted prices £4 14s. 6d.; North West Bessemer, f.o.b. £6 7s. 10d., and of all kinds of pig-iron exported £8 2s. 3d.

LIFE OF ELECTRIC FURNACE LINING.—The Hess Steel Corporation of Baltimore, U.S.A., claims to have established a new record in its plant for the life of furnace linings, when the lining of its No. 2 furnace (a 6-ton Héroult) lasted for 146 heats, but Mr. Axel Paulson, metallurgist to Messrs. Hamilton & Hansell, of New York, in a letter recently addressed to "The Iron Age," states that he has records of a basic-lined Rennerfelt furnace working in the United States in which as many as 160 heats of steel have been made without repairs to the silica roof or sides, and that with acid-lined furnaces more than 200 heats have been made without repairs.

B

Malleable Cast Iron.*

By E. Adamson.

The difference between steel castings and malleable iron castings can be simply stated, that in steel the carbon of the molten pig-iron, etc., is burnt out whilst the metal is *liquid*, and in malleable castings the carbon is precipitated and only part burnt out of the skin of the *solidified* metal.

From the point of view of analyses, malleable castings contain more silicon and sulphur but less manganese than steel, and whilst in steel it is considered advisable to keep the phosphorus under 0.06 per cent., the phosphorus of malleable castings, according to American experience, can safely be a maximum of 0.25 per cent. In malleable castings the carbon can be considerably reduced by annealing but the silicon, sulphur, phosphorus and manganese remain practically constant. Under these conditions, only certain particular classes of pig-iron are suitable for malleable castings, whilst for steel—broadly speaking—any pig-iron can be used, according to process. The following table will serve to illustrate this point :—

	A.	B.	C.	D.	E.
T.C. ..	3.75	3.25	0.15	0.20	0.45
Si	2.00	1.00 max.	0.05	0.05	0.10
S.	0.05 max.	0.10 max.	0.05	0.05	0.05
P.	0.05 max.	1.25	0.05	0.05	0.05
Mn. ..	0.20 to 1.50	1.50	0.10	0.50	0.75

A. is a typical hematite iron used for making *acid* steel, in which process the high percentages of silicon and manganese are oxidised, as illustrated in column C.

B. is a typical pig-iron suitable for making *basic* steel, and silicon, sulphur, phosphorus and manganese are oxidised as well as the carbon, as also illustrated in column C.

C. is a typical analysis resulting from the refining of iron by either the acid or basic process, *i.e.*, after carbon, silicon and manganese, and possibly also sulphur and phosphorus have been eliminated, and before the finishing percentages of carbon and manganese are added to the molten metal.

D. is a typical analysis of mild steel for structural purposes, after "killing" and adding manganese.

E. is a typical analysis of a higher carbon steel for rails, etc., after adding carbon and manganese.

With regard to malleable pig-iron, as the sulphur and phosphorus cannot be materially altered either in the melting or in the processes of conversion, only the first of these irons—A.—*i.e.*, hematite iron, is suitable for malleable castings. For these castings, both the silicon and manganese of A are much too high, therefore a harder fracture of iron is required. Unfortunately, to obtain this harder iron in the original pig means higher sulphur, for in ordinary hematite irons, a decrease in the silicon contents—or, more correctly, a closening of the grain of the pig-iron—indicates in a general way a practically certain increase in the sulphur contents. Silicon and sulphur are, however, not interdependent. Without attempting to be scientifically accurate to the third place of decimals, the following table will serve to illustrate this point :—

	A.	B.	C.	D.
Total carbon ..	3.75	3.50	3.50	say 2.00
Silicon	2.00	0.75	0.50	0.50
Sulphur	0.05	0.20	0.25	0.25
Phosphorus	0.05	0.05	0.05	0.05
Manganese	0.20	0.10	0.05	0.05
Fracture	No. 1	Mottled	White.	Greyish.

A. is an ordinary steel-making or standard hematite, sometimes called Bessemer iron.

B. shows an approximate analysis and fracture of a typical refined hematite pig-iron suitable for malleable castings.

C. is a typical analysis and fracture of B. melted in the cupola and reproduced in a casting—silicon decreased and sulphur increased.

D. is a typical analysis and fracture of C. after annealing.

There are two distinct varieties of malleable castings : the "white-heart" or "steely" fracture, in use in this country and on the Continent, and that mostly in use in the United States, commonly known as "black-heart." It is absolutely necessary to have a white fracture in a malleable casting before it is annealed, and the whole process of producing malleable castings is to convert the combined carbon into free carbon and to slightly reduce the total carbon contents by oxidation. To do this successfully, two things in addition to a white fracture must be considered :—(1) The temperature at which annealing takes place, along with the length of time the castings are retained at a given temperature, and (2) the composition—outside of carbon—of the unannealed castings. The question of temperature is of great importance because it means the difference between a close and open fracture in the finished castings, and a difference in the character of the free carbon—whether it is finely divided or coarse.

It can be stated in a general way that the alloy, carbon and iron, particularly when the carbon is over 3 per cent., is most unstable when exposed to a temperature below the melting point, and any slight variation in temperature, whether in dealing with the molten iron or in the annealing afterwards, may have an influence, and sometimes a very unexpected one, on the final product. It has always been assumed that carbon, when iron is molten, is in the combined form—the term "combined" being used here because it is more generally understood. On this assumption, Sauveur makes the following statement :—"The higher the temperature at which cementite forms, the more readily it is converted into iron and graphitic carbon during solidification and subsequent cooling." In other words, the higher the temperature to which molten iron is taken, the more readily is the carbon converted into graphite. Sauveur is dealing with what is known in the pig-iron world as "rich grey" iron, and six years ago I published data which dispose of the commonly held theory that even if the cold pig-iron contains large quantities of graphitic carbon, when the iron is again melted the graphite is again dissolved and becomes combined in the molten iron.

A point of great importance to the malleable iron-founder is that *graphite carbon begins to form in the molten iron*, and if an iron is melted very hot and held for some time in the molten condition before casting, there is a possibility, if the iron is sufficiently hot, of graphite being formed before the molten metal is poured into the casting, which would give a mottled fracture before annealing. The same thing might happen if the iron were "cold" before pouring.

Another point of interest in connection with molten iron is that the higher the temperature of casting, the deeper the chilling property, or the more easily is a white fracture produced, and in annealing there would be a liability under such conditions of precipitating the carbon more quickly than if the same metal were cast at a slightly lower temperature. These are some of the pitfalls of dealing with molten metal and pouring it into the moulds.

Having, however, obtained a suitable white fracture in the unannealed or "hard" casting, the percentage of precipitation of free carbon as either temper carbon or graphite, and the percentage of carbon

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oxidised during annealing depends upon temperature of, and time in, the annealing oven in contact with oxide of iron. Charpey and Grenet in 1902 published the results of their investigations on the influence of silicon on the precipitation of carbon in annealing cast iron. These results on influence of silicon are given in column 1, Table I., and to this table has been added the similar influence of sulphur, manganese, and total carbon, which are given as the results of practical experience, but there is no exhaustive similar work on the influence of sulphur, manganese, and total carbon which has yet been published. Hatfield has confirmed these silicon results and slightly extended the investigation. Sulphur, phosphorus, and manganese need not vary materially in the production of suitable pig-iron for malleable castings, but there is a liability for silicon to vary, and also the ratio of free and combined carbons, and from this point of view only the silcon and carbons are perhaps the most important things to consider in the production of malleable iron castings. For the purpose of simplifying my remarks I am using the term "free carbon," because in annealing, if the temperature is sufficiently low, the precipitated carbon in the finely divided form is called "temper carbon," and it is only on prolonged heating at higher temperatures that carbon is converted into true "graphite," giving an open-grained casting, and "free carbon" covers both terms.

TABLE I.

	(1) Si.	(2) S.	(3) Mn.	(4) T.C.
1. Separation of G.C. or free carbon is induced at a temperature which is lower*	the higher the Si.	the lower the S.	the lower the Mn.	the higher the T.C.
2. At a constant temperature the separation of G.C. is effected progressively at a rate which is slower the lower the temperature	the lower the Si.	the higher the S.	the higher the Mn.	the lower the T.C.
3. The contents of C.C. which correspond to equilibrium at a given temperature diminishes	when the Si increases	with lower S.	with lower Mn.	the higher the T.C.

* Separation of G.C once commenced will continue below that at which reaction is induced.

Silicon.—Charpey and Grenet laid down the principle that the separation of graphite or of free carbon is induced at a temperature which is lower the higher the silicon. In other words, the higher the silicon, the lower the temperature at which carbon is converted into free carbon. From this principle it might be assumed that in order to anneal larger castings at the same temperature as smaller ones it would be well to make larger castings high in silicon and smaller ones low, but the very reverse is necessary, not from this point of view, but in order to make sure of a white fracture in the unannealed metal in the various sizes of castings. Therefore there is a considerable difference in the necessary annealing temperatures for small castings, not only on account of the size of the casting, but because the larger the casting the lower should be the silicon.

Whilst it is quite possible to anneal a casting and get an excellent malleability result with a silicon of 1.00 per cent. or even over, if the fracture is white before annealing, it is not possible to use such a high percentage of silicon for the average size of malleable casting, and in a general way a casting with a silicon of about 0.50 per cent. gives excellent average results, both for large and small castings; but the smaller the casting the higher the limits of the silicon contents which will produce a white fracture in the hard casting.

Some of Charpey and Grenet's results are given in detail in Table II., and these can be taken as representing sound principles of annealing.

	Heating.	Temp.	G.C.	C.C.
Si. 0.80	1 hour	800	0.10	3.19
	4 "	800	0.22	3.07
	1 "	900	0.30	2.97
	2 "	900	0.60	2.40
	4 "	900	1.58	1.14
	1 "	1000	0.37	2.49
	2 "	1000	1.50	1.41
	4 "	1000	1.47	1.21
Si. 1.20	1 hour	700	0.06	3.42
	2 "	700	0.11	3.30
	4 "	700	0.29	3.13
	1 "	800	0.12	3.80
	2 "	800	0.51	2.47
	4 "	800	1.64	1.56
	1 "	900	2.28	0.90
	2 "	900	2.32	0.90
	4 "	900	2.35	0.99
Si. 1.00	1 hour	700	1.39	1.90
	2 "	700	2.09	1.19
	4 "	700	2.67	0.28
	1 "	800	2.36	0.78
	2 "	800	2.31	0.89
	4 "	800	2.43	0.54
	1 "	900	2.33	0.88
	2 "	900	2.32	0.90
	4 "	900	2.33	0.90

The content of C.C. which corresponds to equilibrium at a given temperature diminishes when the silicon increases :—

Si.	1100°		1000°		900°		700°	
	G.C.	C.C.	G.C.	C.C.	G.C.	C.C.	G.C.	C.C.
0.07 ..	1.15	1.74	1.03	1.74	—	—	1.87	0.43
0.27 ..	1.26	1.93	1.00	1.62	—	—	—	—
0.80 ..	1.61	1.26	1.60	1.52	1.67	1.17	2.56	0.38
1.25 ..	2.10	1.02	2.20	0.98	2.32	0.90	—	—
2.10 ..	2.18	1.00	2.10	0.93	2.33	0.90	2.67	0.28

The content of C.C. which corresponds to equilibrium diminishes when temperature is lowered :—

Temp.	Fonte 1.		Fonte 3.	
	G.C.	C.C.	G.C.	C.C.
1170 ..	0.50	2.61	1.42	1.69
1170 ..	1.15	1.74	1.49	1.48
1000 ..	1.03	1.74	1.35	1.55
900 ..	—	—	1.91	0.99
800 ..	1.15	1.31	2.09	0.43
700 ..	1.87	0.43	2.56	0.38

Total Carbon.—Column 4, in Table I. shows that the separation of graphite or free carbon is induced at a temperature which is lower the higher the total carbon, and at a constant temperature the separation of graphite or free carbon is effected progressively at a rate which is slower, the lower the temperature and the lower the total carbon. It is rarely that in any even refined iron the total carbon will be below 3.00 per cent., whilst in some irons—particularly Swedish—it is possible that this may be nearly 4.00 per cent., and the percentage of carbon has its own particular and separate influence in annealing. As a general principle, if the casting contains over 3.50 per cent. total carbon it will anneal more easily, even with a slightly lower silicon than usual. Therefore, the percentage of total carbon in the casting has a decided influence in the annealing, and if the carbon is below 2.75 per cent. the casting will be found somewhat difficult to anneal at ordinary temperatures, but it will come out of the oven harder and of course with a higher tensile. Also, the higher the total carbon the quicker is the precipitation of free carbon and the shorter time necessary to anneal.

Sulphur.—Column 2 in Table I. : In considering the influence of sulphur simply, the lower the sulphur the

lower the temperature of annealing, or the shorter the time necessary to effect annealing. In British or "white-heart" practice it is quite possible to get a good casting with sulphur 0.25 per cent. or even higher, but the annealing requires much greater attention, and the difference in the temperatures used in England and on the Continent, as against those used in America, is partly due to the difference in the percentage of sulphur. A higher temperature is required to anneal castings high in sulphur even when high manganese is present, and this higher temperature is liable to cause a precipitation of free carbon as graphite, because the crystals are enlarged at the higher temperature; and what is most important, the margin of safety between under-annealing and over-annealing is much greater if the sulphur is low, say 0.05 per cent. It is generally conceded that either an under-annealed or over-annealed casting with such a low sulphur is much more malleable than an under or over-annealed high-sulphur casting; in fact, the high-sulphur casting if under-annealed would be brittle, and if over-annealed the skin would peel.

Manganese.—Column 3 in Table I. shows that the lower the manganese the more easily annealing takes place, but the same rule applies to malleable castings as applies to steel—a certain percentage of manganese will make malleable castings more "malleable" and forgeable, which of course "malleable" implies. It is not necessary to go further than "black-heart" castings, which usually contain about 0.40 per cent. or even 0.50 per cent. manganese, and which easily bend. Also, to prove the advantage of the presence of manganese I have attempted to forge a well-annealed casting containing manganese 0.50 per cent., and one with manganese 0.75 per cent. The former, with manganese 0.50 per cent., was hammered to a chisel edge; whilst the latter, with manganese 0.75 per cent., annealed at the same time as the other, did not take quite such a fine edge, but was perfectly malleable and forgeable.

It is claimed that manganese neutralises sulphur and that, say, 0.50 per cent. manganese would completely neutralise about sulphur 0.25 per cent. That is to say, sulphide of manganese would be formed, which it is stated has no influence in annealing; but so far as I have been able to gather there is no *actual proof* of this theory. If it is correct, then a casting with sulphur 0.25 per cent. and manganese 0.50 per cent. should be as easily annealed as if no sulphur and no manganese were present, but whilst not denying that with a small percentage of sulphur and a high percentage of manganese, sulphide of manganese may be formed *in the molten metal* and which has no influence upon the mechanical tests of iron, I have not been able to obtain any evidence that this holds good with the higher percentages of sulphur such as found in malleable castings. In fact, it is well known that pig-iron high in sulphur and manganese does not anneal easily, and as evidence that it does not, I am informed by an American friend that in "black heart" practice in America with sulphur 0.12 per cent. and with usually 0.50 manganese present it is not found possible to get a "black-heart" casting at the temperatures commonly used to obtain the precipitation of the temper carbon well-known in "black-heart" castings, the experience being that the presence of sulphur 0.12 per cent. interferes with this.

Phosphorus.—The original irons used for "black-heart" castings in America were charcoal irons, which contained phosphorus 0.225 per cent., and this produced excellent castings with phosphorus from 0.225 per cent. to 0.25 per cent. With the advent of coke irons, malleable ironfounders have been able to obtain iron with less phosphorus, but it has been shown that it is quite safe to have phosphorus between 0.20 per cent. and 0.25 per cent. in malleable castings. From the ironfounder's point of view this improves fluidity, and if there is any influence on annealing the influence will be somewhat similar to that of silicon, but there does not appear to be any difference in the mechanical tests.

Annealing Temperatures.—The most important thing in malleable castings is annealing. It is difficult to give a standard figure of what is the best annealing temperature and the proper length of time to anneal. That entirely depends upon two conditions—the class of iron, as well as the composition, which is being dealt with; and also the size of the castings; but to this can be added the likes and requirements of customers—for some require chiefly strength, and others malleability—the former being a much harder annealed casting than the latter, strength being obtained at the expense of malleability. It appears to be well recognised that the smaller the casting the less the time required to anneal and the lower the necessary temperature. Therefore when large and small castings have to be annealed in the same oven, it is necessary to put the small castings as far into the centre of the annealing box as possible, and also into the coolest part of the oven. With the large outputs of repetition work so common in America it is possible to have sufficient small castings to anneal together, and these can be treated accordingly in a separate oven. The customary temperature in this country and on the Continent for so-called "white-heart" castings is 900 degrees C. to 970 deg. C. (1,652 deg. Fah. to 1,778 deg. Fah.) and the effect of this temperature on the carbon of a well-annealed casting is to practically decarburise the skin or outside of the casting, and convert the free carbon into graphite, with a gradual decrease in total carbon from the centre and graphite towards the skin. A prolonged annealing also at this

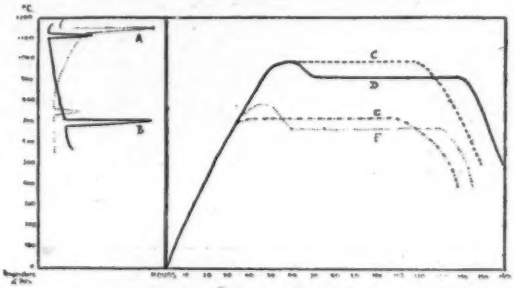


FIG. 1.—A = HEATING CURVE. B = COOLING CURVE. C AND D = ANNEALING TEMPERATURE, BRITISH PRACTICE. E AND F = ANNEALING TEMPERATURE, AMERICAN PRACTICE.

temperature has the effect of increasing the size of the graphite and also of the crystals of iron.

The principles stated in Table I. and shown diagramatically in Fig. 1 are, shorter annealing at the higher temperatures, and starting separation at a higher temperature, and then lowering. The curves C and D apply to British practice, and E and F to "black-heart." At the left side is given the heating, and cooling curves A and B, from which it will at once be seen that the annealing of "black-heart" takes place about the lower of the two chief critical points, whilst in British practice the annealing temperatures are well on towards the critical point of separation of graphite. From these curves the reason of the difference between the finely divided or temper carbon and graphite will be more appreciated. Condensed, the table means that the higher the total carbon and/or silicon and the lower the sulphur and/or manganese, the lower the necessary annealing temperatures. Further, the lower the annealing temperature:—(1) the closer the grain of the iron; (2) the finer the free carbon as temper carbon; (3) the stronger and more "malleable" the casting; (4) the greater the factor of safety in under- or over-annealing; (5) the fewer the wasters; (6) the cleaner the surface of the casting; (7) the less fuel consumption in annealing. And, the higher the annealing temperature:—(1) the coarser is the grain of the iron; (2) the coarser the free carbon, probably as graphitic carbon; (3) the weaker and less "malleable" the casting; (4) the

narrower the margin of the factor of safety in under or over annealing; (5) the greater the risk of wasters; (6) the greater the risk of bad surfaces; (7) the greater the fuel consumption.

"*Black-Heart*" *Castings.*—It is only necessary here to refer to a few of the most important points of difference between these and "white-heart" castings. The same principles already detailed as laid down by Charpey and Grenet apply, and Moldenke gives the analysis of good "black-heart" malleable castings as follows:—Si., 0.45 to 1.00 per cent.; S., up to 0.07 per cent.; P., up to 0.225 per cent.; Mn., 0.30 per cent.; T.C., above 2.75 per cent. The principal differences are sulphur and the temperature of annealing, the latter of which is given as about 732 deg. C., *i.e.*, 1,350 deg. Fah., or a minimum and maximum of 677 deg. C. to 760 deg. C., *i.e.*, 1,250 deg. Fah. to 1,400 deg. Fah. These temperatures are for castings where the iron has been melted in the air or Siemens furnace, but for iron which has been melted in the cupola it is generally assumed that the annealing temperatures should be about 100 deg. C. higher. This lower temperature as compared with British practice for "white-heart," together with low sulphur and the presence of a little manganese, has the effect of precipitating the carbon as a very finely divided free or temper carbon, and at these low temperatures the larger form of graphite carbon is not formed. Also, only the skin of the casting is decarbonised, and immediately behind the skin is a very high percentage of total carbon as temper carbon.

Pig-iron.—Apart from phosphorus in hematite, which can be controlled in the blast furnace within narrow limits, there is absolutely no regularity in the composition of the ores available for making hematite iron. Next, with modern methods of making pig-iron in a blast furnace 80 ft. high and a capacity of perhaps 20,000 cub. ft., containing upwards of 300 tons of minerals and making 150 tons of pig-iron per day, it is physically impossible for the pig-iron maker to produce direct from the furnace absolutely regular grades of iron either in fracture or analysis, or both combined. What scientists call the alloy of carbon and iron—which, practically speaking, is pig-iron, or modified by the presence of other impurities—is a most unstable compound, if it is a compound, for there are strong reasons for assuming that so-called combined carbon is only a mechanical mixture of carbon and iron. In malleable cast iron *temperature is everything*, and it may be well to point out first the possible variations of temperature, starting in the blast furnace, continuing through casting temperatures both on the pig beds and again in the foundry, and finishing with variations in temperatures in annealing. The added totals of all these variations have a most profound and important influence on the precipitation from combined to free carbon, the temperature influence *per se* being *modified* by the presence of silicon, sulphur, phosphorus and manganese. In direct-cast pig-iron it is absolutely impossible for the ironmaster to guarantee that a given analysis will show a given fracture. A very simple illustration is that the same pig, even a 2-in. × 2-in. pig, will vary in the fracture from one end to the other on the simple ground of rate of cooling.

A much more regular grade of pig-iron both in analysis and fracture, or both, can be obtained from refined iron; or by mixing these variable grades and running them into small pigs. It is quite true the Americans buy their malleable pig-iron to analysis, or chiefly on varying silicon contents, but their grading of pig-iron allows of pretty wide variations. It is:—Sulphur, 0.05 per cent. max.; phosphorus, 0.225 per cent. max.; manganese, 0.60 per cent. max.; and silicon, 0.75 per cent., 1.00 per cent., 1.25 per cent., 1.50 per cent., 1.75 per cent., 2.00 per cent. There is no mention of percentage of carbon, the probability being that if this were also specified the pig-iron makers would decline the specification. Experience teaches that the carbon varies slightly both in percentage and character according to conditions of smelting, and is also slightly modified by the analysis, but is rarely, if ever, under a *suitable minimum*. In a word, carbon percentages cannot be *controlled* in the blast furnace—particularly a modern one.

This American specification for grading malleable pig-iron gives very wide variation in silicon contents, for the malleable ironfounders there recognise that the only way is to take irons of the silicons the ironmaster can give and to stock such irons in their stock-yard, charging their furnaces with the silicon contents they require by mixing. In America, the malleable ironfounders use large open-hearth air or Siemens furnaces, which enables them to retain the molten metal in the furnace and oxidise the silicon until they have obtained a suitable fracture, *which is not possible in British general practice*, because it is necessary to charge into the crucible or on to the cupola an iron of a suitable fracture which will produce with the materials mixed a white fracture in the casting, and if the metal at the spout of the cupola will not produce this white fracture, it has to be scrapped and remelted.

In his experience—*which is the ordinary experience*—the author has met with the following variations in silicon contents and fractures:—White, 0.18 per cent. to 0.88 per cent.; spotted white, 0.32 per cent. to 1.00 per cent.; hard mottled, 0.28 per cent. to 1.07 per cent.; soft mottled, 0.53 per cent. to 1.14 per cent.; No. 6, 0.63 per cent. to 1.09 per cent.; grey, 0.70 per cent. to 1.56 per cent. and upwards. There was nothing in the carbon, sulphur, phosphorus and manganese contents to account for these variations, which are not by any means confined to one brand of iron, but the above figures amply illustrate that *silicon content alone does not control or decide the fracture of pig-iron*, or the fracture of the resulting malleable casting; hence, attempting to grade malleable pig-iron by variation of silicon contents cannot be relied on when it is possible to have grey and white iron of the same percentage of silicon.

It would be quite simple for pig-iron manufacturers to follow the American method of grading by silicon contents rising by quarter per cent. *regardless of fracture* and giving the maximum sulphur, phosphorus and manganese, *providing the ironfounder would take all further responsibility*. The ironmaster would welcome such a form of grading, as it would relieve him of considerable worry and simplify the despatch and storage of his iron, but if he is asked to advise this form of grading he would not do so because he knows that in order to obtain a given fracture of iron—particularly in mottled or white iron—the fracture of the iron before melting in the crucible or cupola must be known, and the ironfounder himself will no doubt confirm this experience. Therefore, fracture as well as silicon contents must be considered in grading malleable pig-iron, more even than in other foundry irons, because mottled irons are much more subject to "chilling" influences than grey. It is possible to partially disprove this statement in the laboratory, by using what it is customary to use in making experiments, viz., "washed" iron containing carbon, but practically no silicon or other impurities, which is melted n a crucible along with a known permentage of high-grade—say 50 per cent.—ferro-silicon. This is excellent practice for research work, and will give *indications* of the *influence* of a particular impurity, but it is sufficient to refer to some of the published tables of such researches to show that even under these ideal conditions there is no absolute regularity between analysis and fracture. In such circumstances it is clear that laboratory experiments cannot always be applied to works practice, although they give indications of what to expect *under certain conditions*. Works results do not always agree with laboratory results.

There is, of course, ample room for the improvement of the present practice of grading by fracture only, and thus simplifying teatment in the malleable foundry, but it is unwise to demand specifications within too narrow limits, and if the practically impossible is demanded by one side it is met on the other side by a blank refusal to even discuss matters. For instance, a demand for a spotted white fracture of practically

the same amount of mottle in every pig and in all parts of the pig is unreasonable, because in producing such a fracture the slightest variation in cooling will make white iron; but as in pre-war days there was a demand for white iron on the Continent because of the custom there of mixing grey and white irons, it was possible to supply the large home demand for a spotted white fracture. At the same time, a spotted white and a white iron are so very near akin that if they are practically the same analysis one can readily be used instead of the other. This is where the value of analysis is of material assistance; in fact, on the same analysis there need have been no distinction between these two fractures. No doubt the demand for spotted white has arisen from experience in melting this fracture alone in crucibles, but it should not be overlooked that there is a large percentage of scrap from the castings to be re-used. By using the cupola for melting, a hard mottled fracture can be used so as to get the same fracture in the casting as would be obtained by melting spotted white in the crucible, because in the cupola silicon is reduced and sulphur slightly increased, both of which tend to harden the iron. The cupola becomes hotter as the melt proceeds, and if it is melting for several hours it would be possible to get the same fracture on the same section of pig as that of the pig charged—showing the influence of melting temperature on fractures.

Grading Pig-iron.—The question of phosphorus within the limits of 0.25 per cent. is a matter of comparatively small moment if the iron is otherwise satisfactory. The greatest likely variable is silicon, and the silicon contents and the fracture depend primarily upon physical conditions rather than purely chemical, the percentage of silicon being determined by the blast furnace charge plus the working of that furnace, as is also the fracture of the iron quite apart from analysis; and in a secondary manner the fracture—not the analysis—of the pig partially depends upon rate of cooling on the pig beds. Further, these fractures or physical properties with normally cooled pig-irons persist from the iron as made in the blast furnace through the iron which may be refined, and as it is necessary to obtain a white fracture in the casting before annealing, it is also necessary to consider fracture together with the analysis in the grading of pig-iron for malleable castings. It has been shown—and this is confirmed not only by the works' experience of founders in this country, but also those of America—that the one aim is to get a white fracture before annealing, *and the silicon contents in daily practice vary considerably in the unannealed, and consequently in the annealed castings.* Before making this statement it has been confirmed from American practice. However, as the majority—in number—of works in this country use crucibles and cupolas for melting, the simplest form of grading would be as follows :—

		Silicon.
1a, 1b, 1c	White and spotted white fractures together	Under 0.40% 0.40/0.60% Over 0.60%
2a, 2b	Hard mottled and medium fractures together	Under 0.60% Over 0.60%
3a, 3b	Soft mottled	Under 0.70% Over 0.70%
4a, 4b, 4c	Grey	Under 1.00% 1.00/1.25% 1.25/1.50%

	Low S.	High S.
S.	0.05% max.	0.25% max.
P.	0.20% „	0.20% „
Mn. ..	0.60% „	0.40% „

In both cases the sulphur would be increased on good melting by 0.02 per cent. in the crucible and by 0.03 per cent. in the cupola, and in each the manganese would be slightly reduced; in the case of the low sulphur iron leaving a slight excess of manganese which would exert a "malleable" influence and generally tend to solidity of casting, as well as give greater fluidity in the molten metal, whilst not materially—if at all—affecting the annealing, except to assist in keeping the grain or fracture close. Such a form of grading would be of material assistance to the ironfounder because if the sulphur, phosphorus and manganese were fairly constant and a maximum percentage, the only thing which need be considered by him is silicon, for the total carbon—particularly in cupola melting—can be left to take care of itself, as this will not *materially* vary in any particular brand of iron.

Under the above form of grading, supposing a foundry using crucibles found grade 1b suited best; then mixing in equal proportions grades 1a and 1c would give them grade 1b. Again, what would be an equally satisfactory mixture and would be almost sure to produce an equally good white fracture would be a mixture of grade 1a, say Si. 0.20 per cent. to 0.40 per cent. white fracture, and grade 2a, say Si. 0.40 per cent. to 0.60 per cent. hard mottled fracture; averaging silicon 0.30 per cent. to 0.50 per cent. white fracture. The fact that the fracture of grade 2a has such a low silicon indicates that the total carbon is higher than grades 1a, 1b, and 1c, and therefore the risk of a slightly lower silicon in the casting is allowable. This illustrates the value of fracture as a guide to total carbon contents, and it is sufficiently accurate for all practical purposes. To demand that the ironmaster should keep total carbon within narrow limits would not only add considerably to the cost, but probably no ironmaster would be willing to guarantee total carbon contents and risk rejection of his iron when the fracture is such a ready substitute, and with little exception sufficiently accurate for practical purposes.

The same method of mixing would not do for use on cupolas. Grade 1a would be, and 1b might be too hard to use alone, because the silicon might be too low for good annealing, for unlike crucible melting, the cupola materially hardens any grade of iron on melting. For example, a very hard mottled iron—nearly spotted white and low in silicon—might even turn white if melted in the cupola and cast into the same section—say 2-in. × 2-in. pig—but if the pig were 3-in. × 3-in. the fracture would be likely to be spotted white. One reason for this is that the percentage of silicon in the pig is reduced on melting the iron in the cupola by nearly 0.25 per cent., and hence the solidification of the molten metal is liable to be much quicker by being chilled, and in mottled grades of iron, the quicker the cooling the whiter the iron. Therefore the following mixing would be suitable :—

(1) 1c could be used alone.
(2) 1a, say Si. 0.40% to 0.60% white fracture.
2b „ Si. 0.60% to 0.90% hard mottled fracture.

$$\frac{\begin{array}{|l}1.00\% \text{ to } 1.50\% \\ 0.50\% \text{ to } 0.75\%\end{array}}{2} = 0.625\%$$

Deduct oxidation loss 0.20%

Contents of casting, about silicon .. 0.425%

(3) In the same way 2a. and 2b. could be mixed in equal quantities, and give an average hard mottled.
(4) Also 1b. and 2a., and so on.

Continental Grading.—It has been the custom on the Continent generally to use only white and grey malleable irons and mixing these two grades—whether melting in crucible or by cupola—in varying proportions to suit the class of casting being made, and also to suit the method of melting. Using these two grades only would simplify grading considerably, but great care must be taken to have exact proportions.

Analyses of Castings.—Fairly typical analyses for the average size casting are as follows :—

	Low sulphur.	High sulphur.
Silicon ..	0.50% to 0.60%	0.50% to 0.50%
Sulphur ..	0.06%	0.25% max.
Phosphorus	0.15%	0.15%
Manganese ..	0.40%	0.20%

In ordinary everyday practice, however, silicons in castings usually vary from perhaps 0.50 per cent. to

0.80 per cent., and hence on the same section of casting silicon 0.80 per cent. would anneal easier than 0.50 per cent. On the same sections this would not make *material* difference, although it would be better if silicons could be more regular. Again, if the silicons were constant, and the thickness or sizes of castings varied somewhat, this again would not make *material* difference, for in both these cases the difficulty can be and is *largely* overcome by placing the larger castings in the annealing oven in the region of the greater heat. But where the difficulty may and does arise is chiefly if the large castings contain less silicon than the smaller, as in this case there is the risk of either under-annealing the larger castings, or of over-annealing the latter, when both are annealed together. Even with Siemens and air furnaces there are exactly the same difficulties, but as the outputs are so large it is the custom to anneal in one oven the castings nearest in size, and consequently the only risk is varying silicon in the same size castings.

Reject Castings.—It has been customary to sell the reject annealed castings to makers of annealing pans as the simplest way of getting rid of these wasters, but they can be used again for making new castings. It is not possible, however, to use any but a very small percentage in the crucible, chiefly because the castings contain a substantially lower total carbon than the pig-iron used, which raises the melting point of the castings to a higher temperature than that which it is customary to use to obtain fluid metal from the pig-iron. In cupola practice, however, the melting of the iron in contact with coke and its passage through the coke adds carbon to any material which is low in total carbon, such as annealed castings and steel, and therefore it is possible to mix these reject castings with the cupola mixture when making new castings. The danger, however, is again a question of difference in melting temperature. It can be obviated by melting the reject castings along with a soft mottled or grey pig-iron, running these into pigs, and then using these pigs along with new pig-iron, either in the crucible or cupola, but particularly in the latter.

Steel.—Practically the whole of the above remarks also apply to steel, only in a much stronger degree when mild steel is particularly concerned and because of the very low total carbon—compared with pig-iron it is negligible—the temperature necessary to melt mild steel as compared with pig-iron being 250/300 deg. C., or 20 per cent. to 25 per cent. higher. Hence it will be readily seen that great care and experience is necessary in using steel for mixing, and the iron used with it should be grey or nearly so, depending on the percentage of steel used.

Types of Furnace for Melting.—The following remarks on furnaces are given in view of the comparatively small outputs of possibly 90 per cent. of the malleable founders of Britain, and do not apply in the case of the very large outputs met with in America, where undoubtedly the Siemens or air furnace can be much more and efficiently used.

The crucible is undoubtedly the ideal form of melting, for if the fracture and analysis of the pig-iron used is known, the composition of the castings can be regulated within very narrow limits and varied slightly more or less to meet the composition best suited to each size of casting, so as to anneal several sizes together in the same oven. Whilst ideal, the output is limited, and the cost possibly the highest of any form of melting, but it is an excellent method of melting in the case of very small outputs.

The advisability of using the Siemens furnace depends entirely on output. The first cost of building is high, whilst the cost of melting depends on how many charges are got out during the day, and on keeping the furnace hot overnight. The size of the furnace has also something to do with the cost of melting, particularly in regard to repairs. The Siemens furnace requires an experienced man as melter. The furnace itself is ideal if the output of the foundry is sufficiently large to keep one going, for iron of practically any grade may be charged providing it is sufficiently high in silicon to allow of a minimum oxidation of say 0.50 per cent. Should the first sample from the molten metal show too soft, the metal can be kept in the bath and silicon further oxidised until a white fracture is obtained in the sampling of the bath. Then the metal is tapped into ladles. Whilst the metal is being run out in a sufficiently fine stream to allow of its being caught in small ladles, the silicon in the metal in the furnace is still being oxidised. Hence the first few ladles of metal are higher in silicon than the last few ladles, so that variations in silicon in castings are by no means confined to British practice and due to our methods of grading. A white fracture in the hard or unannealed casting is *all-important*—even if the silicon contents of castings vary. It is far more important than a definite narrow percentage of silicon in the castings.

The air furnace—unlike the Siemens furnace—is an inexpensive one to build, but the cost of working it is higher, chiefly because of the fuel. It is not so easy to get the metal hot and clear melted as in the Siemens. The great advantage of both the Siemens and the air furnace is that the metal is "cleaner."

There have been attempts made—particularly on the Continent—to introduce the converter method of making malleable castings, but it has not proved successful. The critical period of "blow" to obtain malleable is so short that the least error and the molten metal passes into the stage of a high carbon steel which will not anneal at malleable temperatures. In addition to this, it requires a big output of castings to keep even a small converter plant going.

The cupola has the advantage of being, next to the crucible, the most simple form of melting furnace. The comparative cost of melting in the cupola, Siemens, and air furnaces can be put approximately in the ratio of 1: 2: 3; *i.e.*, if the cupola cost 12s., the Siemens would cost 24s., and the air furnace 36s. per ton. The Americans say that castings from cupola melted iron take longer to anneal, presumably on the same silicon and manganese analysis, but unless the sulphur is higher there is no apparent reason for this. Sulphur is, of course, increased by melting in the cupola, not more than perhaps 0.03 per cent. if the coke is fairly pure, but even with the several remelts of scrap this should not exceed 0.10 per cent. For "black-heart" practice this would be objectionable, but it is not so for British "*white-heart.*"

Particular attention has been drawn to the question of pig-iron, because there appears to be a tendency to demand a form of grading within limits which are too narrow to be acceptable to all parties, and the ironmaster's difficulties must be considered, for any method of grading must be such as can be readily met by him. Conducting experiments in crucibles by melting white iron containing no silicon together with given percentages of very high-grade ferro-silicon, so as to produce a given percentage of silicon in the test piece to be treated, is no guide in fixing a specification to be regularly met under modern blast-furnace conditions. As has been pointed out, the fracture of the pig-iron is most important to the malleable ironfounder who uses the crucible or cupola for melting, and this fracture is not "controlled" by chemical analysis, nor is the fracture in any particular size of casting; and if this principle were recognised and accepted by the ironfounder it would materially assist in coming to a proper understanding on the question of suitable grading, which is eminently to be wished for if suitable material is desired to produce the best castings.

In conclusion, the author states that in Great Britain our output of malleable castings is only something like 6 per cent. of that of the United States.

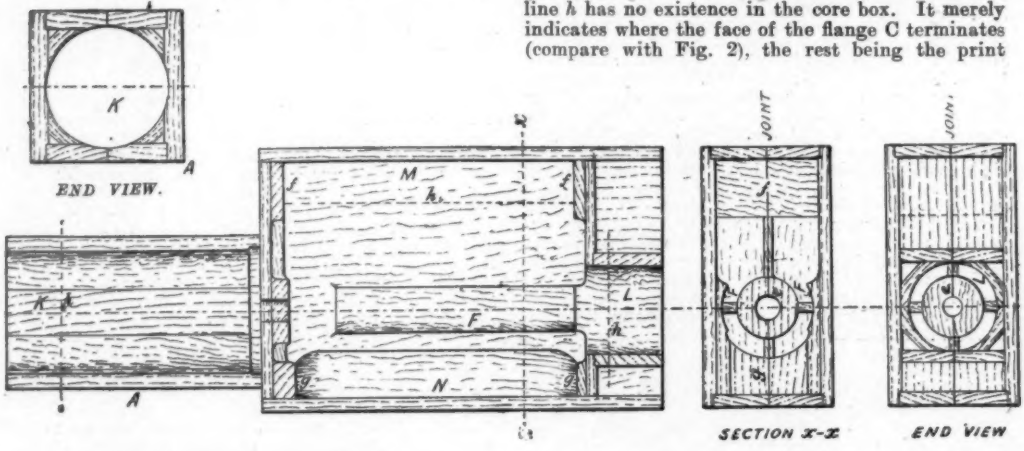
(The discussion on this paper will be printed in our next issue.)

THE CLAY CROSS COMPANY, LTD., Clay Cross, near Chesterfield, has forwarded an attractive pocket diary for 1918, showing a list of the Company's manufactures, well illustrated.

An Engine Cylinder Pattern.—II.

By Joseph Horner.

In this article the construction of the core boxes for the pattern previously described is explained. The scheme of coring adopted may be briefly noted. The cylinder bore and the guide portion are made, as stated, in a single core, united with the narrow neck of the stuffing box. Here the alternative of separate cores suggests itself, which would permit of sweeping the cylinder core on a bar, thus avoiding some core-box work, but it is not worth the timber and time saved in the case of standard patterns, often used. By making the two in one continuous core, with stiff rods passing through the stuffing box neck, the alignment of the two, which is of first importance, is assured. Though the neck is slender, this is compensated by the thorough way in which the core receives support at the outer ends of the cylinder and the guide, and at the sides, where the core cuts through the foot and through the body of the guide. The steam chest core is carried by one print, and those for the steam passages are made separately and inserted in it. The core boxes are illustrated in succeeding figures.



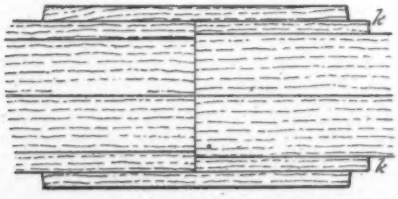


FIG. 13.

The construction of the main box is shown in the group of Fig. 13. It is made in two principal parts, which are jointed with battens. Its relation to casting and pattern is to be seen on a comparison of Figs. 2, 7, and 8, in the previous article. One half box is shown lying open in the joint face, flanked by cross sections of the box, complete to right, and left, and the method of jointing the two portions is seen below.

In this box the portion A takes out the cylinder bore. It is most conveniently made by framing sides and bottom, glueing angle pieces in, and working the curves as shown. The risk of shrinkage of the wood is minimised. Other constructions might be adopted, but this is as good as any. The guide portion of the box seen to the right of the cylinder bore has its enclosing outlines formed with bottoms and sides. The largest depth is that of the print M, in Fig. 10, in the previous article, and the greatest width is that over the prints M and N in Figs. 7 and 10. Blocks are fitted on the bottoms and shaped to give the depth of the print N in Fig. 9, and the curves and the widths of the guides F in Figs. 2 and 3. The sectional view to the right hand shows the stuffing box *e* with its four flanking ribs, one of the blocks *f* which form the end flanges of the foot C (compare with Fig. 2), and one of the blocks *g* that provide the curved ends of the opening in the sides of the guide, compare with Figs. 1 and 2. The dotted line *h* has no existence in the core box. It merely indicates where the face of the flange C terminates (compare with Fig. 2), the rest being the print width. Similar lines terminate prints K and L. The end view of the box at the right shows the fitting of the blocks for the portion L of the core that fills the end print. It is blocked up similarly to the round part K for the cylinder end. The end of the box is not shown closed, which is not necessary, though it might be done. The core maker holds a flat piece of wood against the end while ramming that part of the core up square. The most secure method of uniting the two parts of the box jointed at *j* is shown by the detail in the lower portion of Fig. 13. Long battens are screwed on the backs of the main box sections, and the difference in depth is made up with the packings *k*, *k*.

The steam-chest core box is shown in Fig. 14. If this is compared with Figs. 2, 4, 7, and 9 in the last article, the relationships of the various details will be obvious. The dotted line *l* in Fig. 14 indicates the face of the casting, the supplementary portion to the right being that which fills the print impression O in Figs. 7 and 9. The block *m*, with its ribs, corresponds with the metal round the passage and exhaust cores in Fig. 2, and the three

prints which it carries are those for these cores. The blocks *p*, *p*, next the ends of the box, give the metal of the flange and the stuffing box in Fig. 2, and those at top and bottom *q*, *q*, the metal there, (compare with Fig. 4), but the top block is removed from the upper portion of Fig. 14.

Fig. 15 is the steam passage box, which may be compared with Figs. 2 and 5. The drawing is self explanatory. Fig. 16 is the exhaust box, to be compared with Figs. 2, 4, and 5. Made thus, the passage cores are inserted and cemented in the steam chest core as in Fig. 17, being held in their places with wires and cemented round with clay wash, and their vents brought into the steam chest core into a body of cinders, and so out at the face which abuts against the print face.

An alternative to this, which is not infrequent, is to ram these cores all together as one piece in one box, which saves the trouble and the slight risks that are incidental to bringing off the air through the print joints. But the box is rather more troublesome to make, and the core rods and vent strings are not so easily laid in centrally in the confined spaces. For these reasons it seems a simpler matter to make the cores separately, and unite them after they have been dried.

A box is made for the core to take out the waste oil cup E, in Figs. 1 and 2, the print for which is seen in Fig. 6 in the first article.

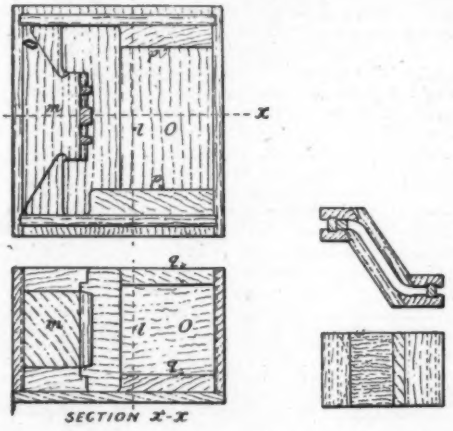


Fig. 14.

Fig. 15.

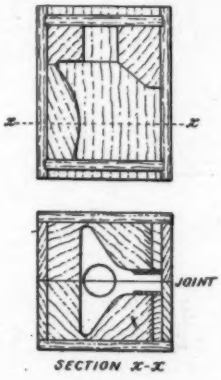


Fig. 16.

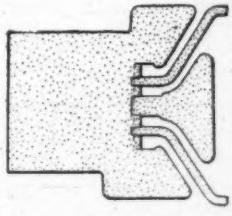


Fig. 17.

Output of Iron Ore in 1916.

According to the Home Office returns, now issued, the output of iron ore in the United Kingdom in 1916 from mines under the Coal Mines Act was 5,648,602 tons, valued at £2,227,329, as compared with 6,080,218 tons, valued at £1,875,872, in 1915; from mines under the Metalliferous Mines Act it was 1,752,614 tons, valued at £2,566,258, in 1916, as against 1,795,887 tons, valued at £1,979,201; and from quarries 6,093,442 tons, valued at £751,575, in 1916, as against 6,358,907 tons, valued at £732,578, in 1915. The total was thus 13,494,568 tons, as compared with 14,235,012 tons in 1915, and 14,867,582 tons in 1914. The pig-iron obtainable from the total output in 1916 is returned at 4,319,096 tons, as against 4,567,351 tons in 1915, and 4,786,090 tons in 1914. Including imports, the total ore available for blast furnaces in the United Kingdom in 1916, exclusive of mill and forge cinder, was as follows:—

	1915.	1916.
	Tons.	Tons.
Output in the U.K.	14,235,012	13,494,658
Imported (excluding "purple ore").	6,197,155	6,933,767
"Purple ore" imported	677,600	712,497
	21,109,767	21,140,922
Exported	1,684	1,113
Total	21,108,083	21,139,809

BAUXITE AND ALUMINIUM IN THE UNITED STATES.—According to statistics prepared by the U.S. Geological Survey the output of bauxite in the United States in 1916 was 425,100 long tons, an increase of 43 per cent. over 1915. It is estimated that of this total output producers of aluminium consumed about 300,000 tons, makers of chemicals about 80,000 tons, and makers of abrasives and refractories about 45,000 tons in 1916. Though the domestic consumption in 1916 also increased 43 per cent. over the consumption in 1915 domestic deposits were apparently able to supply the whole demand and still leave some bauxite for export. The value of primary aluminium produced in the United States in 1916 was £6,780,000, an increase of 108 per cent. over 1915. This increase is, in part, due to the higher price, but is also due in a considerable degree to the greater output of primary aluminium in 1916 than in 1915. The value of secondary aluminium produced from scrap in the United States in 1916 increased more than 300 per cent. over 1915, owing in part to the greatly increased price, but also to greater recoveries of aluminium from scrap. The value of the total domestic production of new metal and metal produced from scrap in 1916 was £11,466,000, as compared with £4,416,500 in 1915. The value of imports of aluminium has continued to decline, but the value of exports has greatly increased. The Aluminium Company of America is now operating four electrolytic aluminium plants in the States. They are those at Massena and Niagara Falls, N.Y.; Maryville, Tenn.; and Badin, N.C. The Badin plant was started in 1916, and was expected to be in full operation in 1917. This plant, construction of which was begun by French capital, was taken over by the American company in 1915, and completed. It is estimated that its capacity, when in full operation, will be about 22,000 short tons a year

Utilising Burnt Sand.

A series of experiments to determine the most economical method of mixing and blending sands for foundry facings and utilising burnt sands was described in a Paper read by R. F. Harrington, at the recent Boston meeting of the American Foundrymen's Association.

The methods of sand-testing used were the bond test, the sieve test, and the transverse-strength test. The first study was the replacement of the sand ordinarily used by a sand carrying 20 per cent. higher bond, which, because of the high bond or active clay substance present, allowed the use of 10 per cent. more old sand in the mixture. The properties of the two sands were :—

	Original mixture.	Mixture No. 1.
Jersey sand No. 3	72	62
Old sand	20	30
Sea coal	8	8
Total bond	307	435
Transverse strength, grams	440	396

Another mixture consisting of 47 per cent. of Jersey sand, 44 per cent. of old sand, 1½ per cent. clay and 7½ per cent. of sea coal gave a total bond of 434 and a transverse strength of 226 grams. While the bond and texture had been maintained, scabbing appeared on many of the castings. Mixing by machine partially overcame the difficulty, but an attempt to decrease the amount of new moulding sand by the further addition of clay showed conclusively that the limit had been reached unless a better blending of component parts was made possible by some other type of machine.

The only advantage to be gained in the operation of the mixer was that it usually permitted the same mixing at a lower labour cost per ton. A careful study of the mechanically and hand-mixed sands under the microscope revealed no marked difference, in so far as the coating of the burnt grains of sand with the new sand and clay was concerned. Results of the breaking of transverse test bars also revealed no greater tenacity of the grain particles, which would be a criterion of the thoroughness of mixing.

To increase the efficiency of all new materials used in the facing by more complete blending, a so-called pan muller was purchased. This machine consisted of a cylindrical pan, with a bottom of cast-iron, about 5 ft. dia. and sides of sheet steel about 1 ft. high. Resting in this pan were two heavy cast-iron rolls approximately 2 ft. dia. and 8 in. wide. These rolls were held in position by guides which allowed revolution only about their respective axes, due to contact with the pan and its contents.

While awaiting the arrival of the muller the mixture No. 2 was used in the foundry for a period of about two months. This mixture, which used 1½ per cent. of Jersey fire-clay, together with a high-bonded Jersey sand, was mixed in a mixer. Eventually it replaced the mixture previously used with a consequent saving of approximately 22 per cent. of new material, or approximately 4s. per ton of facing mixed.

The first test employing the muller as a means of mixing was made for the purpose of determining the effect of the mulling action on the character of the facing. The effect, so far as increased efficiency of all new material added is concerned, is best shown by the results recorded below. They represent the breaking loads on three sets of bars made from the same mixture of sand, but mixed by hand, in the mixer, and in the muller, respectively.

From the following data it is seen that the mixer offers no better means of mixing so far as the strength of the sand obtained is concerned, but that the muller does by its peculiar action offer a far more efficient means of mixing or blending. The results of the tests were :—

Hand prepared mixture No. 1		Machine mixture No. 2.		Muller mixer No. 3.	
Bars.	Ounces.	Bars.	Ounces.	Bars.	Ounces.
A ..	9.5	A ..	10.0	A ..	12.5
B ..	10.5	B ..	9.5	B ..	13.5
C ..	10.5	C ..	10.5	C ..	14.5
D ..	10.5	D ..	11.0	D ..	12.5
E ..	10.0	E ..	9.5	E ..	10.5
F ..	11.0	F ..	10.0	F ..	14.0
G ..	10.3	G ..	9.5	G ..	14.0
H ..	10.0	H ..	10.0	H ..	12.0
I ..	10.0	I ..	10.0	I ..	13.0
J ..	11.0	J ..	10.0	J ..	12.0
Average	10.3	Average	10.0	Average	13.0

The first sand mixtures for facing purposes prepared in the muller varied in clay content from 1 to 7 per cent. and in new sand content from 10 to 50 per cent., these mixtures making use of varying proportions of new sand and clay, in some instances consisting of clay and old sand only, and in other instances of only new and old sand.

After a long series of experiments, it was found that the bond test could no longer be used as a means of measuring the strength of the sand, the muller so increasing the effectiveness of the mixing as to make bond tests no longer comparative. The transverse test and a mechanical analysis were found to be the most satisfactory for judging the character of a sand. The mixtures given in the following table were finally decided to be the best for the foundry in which the experiments were conducted :—

	Mixture No. 3.	Mixture No. 4.	Mixture No. 5.
Old sand	60	57	57
Jersey sand	30	15	—
Beach sand	—	—	20
Clay	3½	—	—
Millville gravel	—	20	15
Sea coal	6½	8	8
Total bond	441	383	262
Transverse strength, grams. ..	355	310	210

These mixtures all received 1½ min. mulling action, and although prepared for different classes of castings, they are based on the principles of the use of such proportions of new sand, old sand and clay as to give a facing which would not when in contact with the hot metal be subject to scabbing or blowing.

The comparative new material costs of the different mixtures were as follows :—

Original mixture.	s.	d.
72 % Jersey at 16s. 8d.	12	0
8% Sea coal at 37s. 6d...	3	0
	15	0

Mixture No. 1.	s.	d.
62% Jersey at 16s. 8d. ..	10	4
8% Seal coal at 37s. 6d...	3	0
	13	4

Mixture No. 2.	s.	d.
47% Jersey at 16s. 8d ..	7	10
1½% Clay at 29s. 2d. ..		5½
7½% Sea Coal at 37s. 6d.	2	9½
	11	1

Mixture No. 3.	s.	d.
30% Jersey at 16s. 8d. ..	5	0
3½% Clay at 29s. 2d. ..	1	0½
6½% sea coal at 37s. 6d...	2	5
	8	5½

Mixture No. 4.	s.	d.
15% Jersey at 16s. 8d. ..	2	6
20% Millville at 16s. 8d.	3	4
8% Sea coal at 37s. 6d...	3	0
	8	10

Mixture No. 5.	s.	d.
20% Beach at 6s. 8d. ..	1	4
15% Millville at 16s. 8d.	2	6
8 % Sea Coal at 37s. 6d...	3	0
	6	10

Sheffield Association of Metallurgists and Metallurgical Chemists.

There has recently come into being, under this title, what promises to be a very valuable addition to the list of technical associations. The aims and constitution will best be seen by reference to the rules, from which the following are abstracted :—

The objects are (1) to provide an Association, with local headquarters and library, in which chemists and metallurgists and others interested in the scientific side of the industries of the district may meet together; and (2) to deal with local interests in any national or other movement, having for its object the raising of the professional status of scientific workers.

Full Membership is open to men who, having attained the age of 24 years :—(*a*) Have suitable academic qualifications (Degree or Associateship of any University or University College, the Institute of Chemistry, or any adequate equivalent subsequently agreed upon), together with three years' experience in a recognised laboratory or some approved practical metallurgical department. (*b*) Have not the above academic qualifications but are of good professional standing, and, in the opinion of the Council, have had over eight years' responsible work and have a sufficient theoretical knowledge.

Associate Membership is open to men who are 21 years of age, and are possessed of academic or other accepted qualifications as for full membership. Associate Members on attaining the necessary qualifications must submit themselves for election to full membership.

Students.—The admission of Student Members will come up for consideration at a later date.

Associates are men over 24 years of age who, whilst not qualified for membership, yet occupy responsible technical positions and are fitted, in the opinion of the Council, to take part in the discussions and enjoy the amenities of the Association.

The Council have the power to elect as Honorary Members men of high standing in the metallurgical and allied industries.

The entrance fee is one guinea for Members and Associates, and half-a-guinea for Associate Members. The annual subscriptions are as follows :—Full Members and Associates, two guineas; Associate Members, one guinea.

A general meeting is to be held once a year, in the month of December, and be called the Annual General Meeting. Monthly meetings are to be held the first Monday in the month for the discussion of papers and matters of interest to the members. Informal weekly meetings are to be held on the Monday of each week. It is intended that when suitable premises are obtained procedure will then be on club lines, in addition to the above arrangements.

The officers elected are as follows :—*President*, W. H. Hatfield, D.Met., metallurgist (J. Brown & Co., Ltd., Thos. Firth & Sons, Ltd.). *Vice-Presidents*, Thos. Swinden, D.Met., metallurgist (S. Fox & Co., Ltd.); J. H. S. Dickinson, Assoc.Met., metallurgist (Vickers, Ltd.); J. C. W. Humfrey, M.Sc., B.A., chief analyst, Admiralty, Sheffield; P. B. Henshaw, Assoc.Met., (technical director, Kayser, Ellison & Co., Ltd.). *Hon. Treasurer*, L. Dufty, B.Met (chief chemist, Sir J. Jonas & Colver, Ltd.). *Hon Secretary*, G. R. Bolsover, Assoc.Met., 31, Rossington Road, Brocco Bank, Sheffield. *Council*, J. W. Ashbury (chief chemist, J. Brown & Co., Ltd.), T. Baker, D.Sc., F.I.C., M.Met. (metallurgist, Steel, Peech and Tozer), C. E. C. Clark, Assoc. Met. (metallurgist, Rowland, Needham & Co.), B. Derby (chief chemist, Cammell, Laird & Co., Ltd.), T. G. Elliott, F.I.C. (chief chemist, Hadfields, Ltd.), J. Evans, F.I.C. (city analyst), B. Methley, F.I.C. (chief chemist, Steel, Peech & Tozer, Ltd.), R. Tyler, F.I.C. (chief chemist, T. Firth & Sons, Ltd.).

The importance of applied science in the national organisation has long been recognised by all thinking men in the industrial world and needs little mention here, since few are unaware of the triumphs achieved by the alliance between science and industry. The primary object of the new Association is to make this alliance still more effective and by facilitating personal contact between applied scientists, metallurgists, chemists, physicists, engineers, etc., to lead to a broadened outlook and a freshening of ideas which should be of the greatest possible value to all concerned. The senior members of the profession, incidentally, will be able to assist the younger members in developing their thoughts and studies in the direction in which they can be of most service to the industry.

The formation of the club as headquarters will provide for a long-felt want in the district. As members of the works staffs will be welcomed, a particularly happy result should be obtained from such intimate contact between the scientific worker and the man in charge of operations in the works. The contact thus obtained should have two results; in the first place the scientific man will, in a pleasant and effective manner, discover, if, indeed, he has not already done so, that he has much to learn from the observant works man; whilst, in the second place, the works man will have the opportunity of appreciating purely scientific work and be led to consider more closely its daily application in works practice. Mutual appreciation and a broad outlook between the two sections will materially help to make effective that increased application of science to industry which must be the order of the day.

Apart from its local activities, the Association intends to co-operate with other similar organisations to form a National Applied Science Association. The promoters hope that every assistance will be forthcoming to make the project a success, and that all members, both of the profession and of the works staffs, not only in the iron and steel, but also in the non-ferrous and allied industries, who consider themselves eligible will put their names forward for election.

INSTITUTE OF METALS.—The annual general meeting of the Institute of Metals will be held in the rooms of the Chemical Society, Burlington House, W.1, on March 13 and 14 next. The presidential address will be delivered and several Papers read and discussed on the first day, and further Papers, including the Fourth Corrosion Report, will be read on the second day. A detailed programme of the meeting will be issued in February. A ballot for the election of members will be held in connection with the meeting. Forms of application for membership can be had, and should be returned not later than noon on March 6 to the Secretary, 36, Victoria Street, Westminster, S.W.1.

Fuel Oil and its Applications.

Under the above heading a lecture was given by Mr. A. F. Baillie (of the Anglo-Mexican Petroleum Company, Limited) before the Gloucester Engineering Society, at Gloucester, on the 15th inst. After a survey of the production and transport of fuel oil he passed on to a summary of its applications and proved advantages in comparison with coal. An abstract of his remarks is appended.

Oil Furnaces.—Apart from the use of fuel oil for steam raising, there are vast numbers of industries using direct heat in which oil is displacing coal, coke and gas firing. These include metallurgical and industrial processes such as brass-melting, case-hardening, annealing, tempering, glass-making, rivet and bolt making, rivet-heating, lead-refining, crucible furnace work, tyre-heating, etc.

General Advantages.—Briefly stated, the advantages realised in the use of oil for industrial furnaces are:—(1) Increased output of plant. (2) Reduction in cost of fuel required for a given amount of work. (3) Saving in time taken by the operation resulting in reduced labour cost and increased output of plant. (4) More uniform results owing to perfect control of furnace temperature. (5) Less waste owing to imperfect work, breakage, loss of metal, etc., according to the class of work for which the furnace is employed. (6) Individual heats can be run and furnaces shut down without waste of fuel. (7) No cleaning out of furnaces is necessary after a day's run; there are no ashes to dispose of, and the whole manipulation of the furnaces is less irksome to the operator. (8) Prolonged life of crucibles. (9) Less floor space required and cleaner conditions in factories.

Calorific Value.—The calorific value of Mexican fuel oil is about 18,900 B.T.U. per lb., as compared with coal, which usually varies between 11,590 and 14,500 B.T.U. per lb. according to the nature and quality of the coal. There is, therefore, an increase of from 30 to 64 per cent. in the heating value of oil as compared with coal, weight for weight.

Higher Efficiency.—The thermal efficiency of an oil-fired boiler is much higher than that obtained with coal firing, as there is perfect smokeless combustion of the fuel. The efficiency of the great majority of coal-fired boilers in this country under average working conditions does not exceed 65 per cent., whereas experience with oil firing shows that 80 per cent., and sometimes more, of the theoretical heat value of the fuel is recovered.

Other advantages are uniformity, saving in storage, saving in labour, flexibility, absence of smoke and ashes, and facility in handling.

Burners.—The burners used for fuel oil are of three types, and are operated either by air, steam or pump pressure and temperature upon the fuel itself, to break up the fuel—which has been rendered more fluid by heating coils in the fuel tank—into a finely atomised dust or spray. Worthy of mention among burners are the following:—(1) Air—Alldays & Onions', Bretts', Kermode's, Lucal, Mexican, Monometer. (2) Steam—Holden, Kermode's, Lucal. (3) Pressure—Kermode's, Meyer-Smith, Wallsend Slipway, White, and several other types.

(1) Air-jet burners use air as an atomising agent from ½ lb. to 50 lbs. per sq. in., but in general industrial practice, air at a pressure of about 2 lbs. per sq. in., and at a temperature up to 200 deg. F., gives the most satisfactory results. Exceptional cases may call for higher pressure. The fuel oil should reach the burner nozzle at a temperature of about 110 deg. F.

(2) Steam-jet burners use steam as an atomising agent from 20 lbs. to 150 lbs. per sq. in., but in general land boiler or locomotive practice, steam at a pressure of about 50 lbs. per sq. in. and preferably superheated, gives the most satisfactory results. With both air and steam burners further economies are obtained, if the induced air for combustion is also preheated.

(3) The pressure system of oil burning entails the use of pumps, heaters and filters, and may be described as follows:—The fuel oil is sucked by means of pumps from storage-tanks through duplex suction strainers (one of which can be cleaned while the other is in operation) and discharged through steam-heated fuel-oil heaters and duplex discharge strainers, similar in design and operation to suction strainers, to control valves to burners on boilers or furnace fronts. The burners in operation are controlled by means of these valves, the quantity of fuel oil consumed per hour being governed generally by the size of orifice in the burner nozzle.

The following figures of actual working results were included amongst other data in the Paper:—

Crudall burner, melting aluminium, one oil-fired furnace doing the work of nine coke-fired. Metal melted in oil furnace in twenty days, 33 tons 5 cwts. 2 qrs. 20 lbs. Quantity of oil consumed for above quantity melted, 844¼ gallons, or 1½ gallons per cwt. Consumption, about 4 gallons per hour. Consumption of oil per 100 lbs. of metal melted, 10.3 per cent. It was recorded that with fuel oil the crucibles lasted 16 days, as against 12 to 15 days with gas. Cost of oil per ton of metal melted, taking oil at 55s. per ton delivered, 5s. 6.7d.

Alldays & Onions Charlier Tilting Furnace, melting yellow brass; 600 lbs. melted in 40 minutes; consumption, 12 per cent. Melting red brass (*i.e.*, G.M.), 600 lbs. melted in 50 minutes; consumption 15 per cent.

Morgan's Patent Tilting Furnace, melting yellow brass; 450 lbs. melted in 50 minutes; consumption, 12.5 per cent. Melting red brass (*i.e.*, G.M.); 450 lbs. melted in 60 minutes; consumption, 15 per cent.

Bridford Furnace, melting yellow brass; 40 lbs. melted in 30 minutes; consumption, 12.5 per cent.

Morgan's Tilting Furnace, melting copper; 450 lbs. melted in 75 minutes; consumption, 17.5 per cent.

LARGEST AMERICAN ELECTRIC STEEL FURNACE. — The largest electric furnace in the United States is at work in the steel department of the Carnegie Steel Company, at Duquesne. It is of the Héroult type and has a capacity of 20 tons, but has made as high as 25 to 30 tons. It began work in November, 1916, and requires 175 kw-hrs. per ton of steel operating basic on hot metal. There are three electrodes of 12-in. graphite, and the electrode consumption is now from 3 to 4 lbs. per ton of steel. The current is 3-phase received at 6,600 volts, and is transformed to 100 volts at the furnace. Six heats are made per day of 24 hrs., and each heat averages about 2½ hrs. The steel produced by the furnace is used principally for small gun forgings, ball races, and steel balls.

Queries.

(Replies from our readers are solicited.)

Brass Melting.

How many coke-fired furnaces in *ordinary usage* are worked by one melter? Does he fetch and prepare his own coke, clear ashes, lift his crucibles and clay-up furnaces?

How many 80-lb., also 100-lb., pots of gunmetal should be melted in 6 furnaces for a day of 9½ hours by a man with boy as helper for coke and ashes, etc.? Some furnaces, I know, will burn fiercely and melt more rapidly on some days than others.—" NEOPHYTE."

Wastage in Brass Melting.

Can you tell us what is the recognised percentage of wastage in melting brass and gunmetal in brass foundries?—L. E. F.

Blow-holes in Castings off Chills.

For some time I have been puzzled by the presence of blow-holes in castings off chills and wrought-iron pins. The wrought-iron pin is well warmed before being put into the mould; at the time of casting its temperature is about 500 to 800 degrees F. The mould is cast through a runner so that the metal pitches on the side of the pin. My theory is that the wrought-iron pin when brought up to a certain temperature by the molten iron gives off a gas. An appreciable amount of time elapses before this point is reached, and the metal has commenced to solidify on the surfaces of the mould and around the pin. At the point when the gas is liberated, the metal round the pin would be in a putty-like state, while above it would be more of the consistency, say, of treacle, which would allow the gas to expand as in the sample submitted for inspection. I have met this trouble of gas holes or blow-holes in castings where chills or denseners have been used, and in no case does it show itself by disturbance in the runner or risers like an ordinary blow does. There is generally a skin ⅛ in. or more thick over the blow-hole. Sometimes a forcing back of metal through the risers some minutes after the mould has been cast has been noticed, but there is no bubble or violent disturbance. The trouble with regard to the denseners has been overcome by replacing them with new ones after using them five or six times. From one of the discarded denseners a piece was cut and roughly polished. It plainly showed the depth to which the iron had been burnt, and seemed to indicate a border-line at which the change takes place. Can any reader tell me what this change is, and if a gas is given off?—" B-H."

Dealings in Steel Scrap.

Since scrap material was first scheduled as a war material, the Ministry of Munitions has issued three Orders and three notices regulating dealings and prices, and a further " Notice of Modification of General Permit " was issued last month. Under this notice, which is dated January 3, 1918, the Ministry withdraws the two notices of August 28, 1917, but not so as to revive anything withdrawn or cancelled thereby. The general permit will henceforth take effect as if the war material referred to in the orders of March 22, 1917, and August 28, 1917, respectively, were included in the order of July 7, 1916, and the undermentioned material and prices were specified in the schedule to the general permit, the prices, where material is already specified in the schedule, to be in substitution for the prices contained in the schedule. Condition 2 of the general permit will not apply to any sale or purchase of the war material referred to in the orders of March 22, 1917, and August 28, 1917, under a contract in writing entered into prior to January 3, 1918, at a price not contravening that permitted up to such date.

Maximum Prices above Referred to for Steel Scrap.

1. (a) Heavy steel melting scrap, £5 5s. per ton.
   (b) Steel planings, turnings and borings, £3 5s. per ton.
   (c) Steel planings, turnings, and borings, mixed with wrought-iron or other material, £2 10s. per ton.
   (d) All other classes of steel scrap, whether or not mixed with wrought-iron or other material, £4 15s. per ton.

2. To the prices specified in Clause 1 hereof a sum not exceeding 2½ per cent. on such prices may be added in the case of sales by recognised scrap merchants.

3. All the prices specified in Clause 1 hereof are free on rail or free in barge at the nearest convenient siding or wharf to the place where the scrap lies at the time of sale; the carriage at actual cost or at a fair average rate agreed between the seller and the buyer may be charged to the buyer up to a maximum of 10s. per ton.

4. Special permits to purchase steel scrap sold with guaranteed analysis may be granted on application, but in no case will permits be granted for such purchase at prices exceeding the following :—

Heavy steel melting scrap containing not over .04 per cent. phosphorus and sulphur, £6 5s. per ton.

Heavy steel melting scrap containing not over .05 per cent. phosphorus and sulphur, £6 per ton.

All communications with reference to the above order should be addressed to : The Controller of Steel Production (Room 381), Ministry of Munitions of War, Whitehall Place, London, S.W.1.

"F.T.J." Bookshelf.

Aluminium and Its Congeners, including the Rare Earth Metals. By H. F. V. Little.—London: Charles Griffin & Company, Limited, Exeter Street, Strand. (15s. net.)

This is Volume IV. of " A Text-book of Inorganic Chemistry," to be published by Messrs. Griffin, under the editorship of Dr. J. Newton Friend, deals with the elements in Group III. of the " Periodic Table," the group being boron, a non-metal, which seems to be gaining some importance in steel manufacture, since Dr. Léon Guillet, of Paris, presented his Paper on " Boron Steels " to the Iron and Steel Institute in 1907. In the shape of borax, boracic acid, etc., the element is doing useful work in other fields. Boron and aluminium are members of the short periods in the Table, the remaining elements belonging to the long periods. Aluminium is dealt with in Chapter III., and clay and ceramics, including fire-clay goods, briefly in Chapter IV., ultramarine in Chapter V., while the next four chapters are devoted to the more or less known elements gallium, indium, thallium, and scandium. The rest of the volume, more than one-half, is a masterly treatise on the rare earth elements and actinium, with its disintegration products, which are in very competent hands, the author being chief chemist to Thorium, Limited. There are also short notices of, or references to, emery, felspars, permutits (including sodium permutit used for water-softening), and other minerals and chemicals. The volume aims at giving a tolerably comprehensive, though not exhaustive, and readable account of the inorganic chemistry of the elements in the group, together with cerium and the ter-valent rare-earth elements, and, so far as was possible without over-burdening the text, the results of modern physico-chemical work have been included. The student who wishes to pursue his researches further will find the bibliography in the numerous foot-notes extremely useful.

Melting Brasses and Bronzes.*

By H. L. Reason.

In order to successfully make copper alloys, much attention must be given to the process of melting. Many of the brassfounder's troubles are due to the insufficient care during the process of melting, and a large amount of defective work can be traced to the following:—

(1) Metal allowed to remain in the furnace after the required temperature has been reached.
(2) Metal overheated.
(3) Metal cast either too hot or too cold.
(4) Oxidation.

Insufficient care is taken in brassfoundries generally to prevent oxidation, particularly when melting copper and bronzes. It will often be found that metals are placed in crucible without any protection, and allowed to melt in such a way that dross or oxides are formed, with defective castings inevitably resulting.

Unless furnaces and chimney stacks are properly designed to ensure the metal being melted at the correct speed, the best results cannot be obtained. Not only does the metal deteriorate by being in the furnace too long, but unnecessary wear and tear is put upon the crucibles. The proper speed for melting brass after the first heat in coke-fired lift-out crucible furnaces with natural draught is 40 to 60 minutes for pots up to 300 lbs.

It is necessary to keep copper and bronzes covered with charcoal during the melting. Not only does the charcoal give a protective covering to the metal, but it acts as a flux by helping to remove the dross or oxides that are always present in molten metal. In melting brasses, owing to the high zinc content and lower melting point if the metal is melted at the correct speed, no charcoal covering is necessary. The melting and boiling points of the principal basis metals:—

TABLE I.

	Melting points.		Boiling points
	Degrees Fahr.	Degrees Cent.	Degrees cent.
Copper	1921.5	1083.0	2310.0
Zinc ..	786.9	419.4	905.7
Tin	449.4	231.9	1450–1600
Lead	621.1	327.4	1525

Table II. gives the melting points of a range of commercial bronzes and brasses as determined by Gillett and Norton. It will be noticed the melting point is governed by the copper content.

Table III. gives results by Longmuir, showing the effect of casting-temperature on the physical properties of copper alloys. It will be noticed there is a marked difference between the melting and casting temperature of copper and other metals; in brass it is 100 deg. C., whilst copper is 463 deg. C. The difficulty many brass founders experience in

TABLE III.—*Effect of Casting Temperatures on Mechanical Properties of Copper Alloys.*

Alloy.	Cu.	Zn.	Sn.	No.	Casting temperature. °C.	Maximum stress. Tons per sq. in.	Elongation Per cent. On 2 in.	Reduction of area. Per cent.	Melting and boiling points. Melting.	Boiling.
Gun metal ..	87.5	1.80	10.20	1	1173	8.38	5.5	4.2	995	—
				2	1069	14.84	14.5	16.7		
				3	965	11.02	6.0	6.4		
Yellow brass ..	73.0	26.0	—	4	1182	11.48	37.7	31.4	920	—
				5	1020	12.71	43.0	35.7		
				6	850	7.45	15.0	15.2		
Red brass ..	89.6	10.2	—	7	1308	6.85	13.2	12.6	995	—
				8	1073	12.65	26.0	30.3		
				9	1058	5.67	5.5	6.6		
Muntz metal ..	58.6	40.5	—	10	1038	12.45	6.0	10.6	885	—
				11	973	18.89	15.0	16.1		
				12	943	16.29	9.5	14.8		
Copper	—	—	—	124	1500	6.60	8.5	All from one crucible.	1083	2310
				125	1446	7.80	11.0			
				126	1141	8.80	8.0			
Zinc	—	—	—	118	580	1.30	—	Poured at intervals from one crucible	419.4	905.7
				119	528	1.81				
				120	491	1.37				
Tin	—	—	—	—	—	—	—	—	231.9	1450-1600
Lead	—	—	—	—	—	—	—	—	327.4	1523

TABLE II.—*Melting Points of Copper Alloys.*

Alloy.	Approx. composition.				Melting point.	
	Copper	Zinc.	Tin.	Lead.	Cent.	Fahr.
Gun metal ..	88	2	10	—	995	1825
Leaded gun metal ..	85½	2	9½	3	980	1795
Red brass ..	85	5	5	5	970	1780
Low grade red brass ..	82	10	3	5	930	1795
Leaded bronze	80	—	10	10	945	1735
Bronze with zinc	85	5	10	—	980	1795
Half yellow half red	75	20	2	3	920	1690
Cast yellow brass ..	67	31	—	2	895	1645
Naval brass ..	61½	37	2	—	855	1570
Manganese bronze ..	—	—	—	—	870	1600

* Abstract of Paper read before the Birmingham Local Section of the Institute of Metals.

producing sound copper castings is due to the metal not being raised to the correct casting temperature. For this work the author has found it necessary to melt as quickly as possible to nearly boiling point, keeping the metal well covered with charcoal, and adding phosphorus just before taking from the furnace, and pouring into moulds as quickly as possible.

The author gave a full description of the principal stationary and tilting coke-fired furnaces with the various class of work for which the furnaces are most suitable.

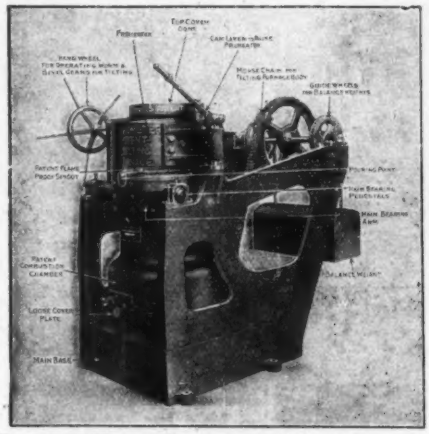


FIG. 1.—800-LB. MONOMETER TILTING FURNACE.

The large quantities of non-ferrous metal required for munition work have resulted in various developments in furnace design. Fig. 1 is an 800-lbs. Monometer tilting furnace. These furnaces can be arranged for either coke, oil, or gas. With oil the melting speed for 60/40 metal is 1 hour 10 minutes, and the life of the crucibles is 60 heats. The enlarged combustion chamber gives uniform heat on the crucible. The oil consumption is 1¼ to 1½ galls. of creosote or tar oil per cwt. of metal melted. The blast pressure is 1 lb. with the oil tank 12 ft. high. For heavy Texas or Mexican oils the pressure requires to be 2 lbs.

Fig. 2 shows one of these furnaces working in connection with a turntable, carrying 2-in. bars 40 in. long in iron moulds. With this apparatus two gangs of men turn out every 24 hours 11 tons of bars.

Fig 3 shows the "Empire" oil furnace, by Alldays & Onions. The special features in connection with this furnace are the vertical burners and constant pouring point. Fig 4 is a sectional view of the furnace. For 150- to 600-lbs. size pots only one burner is required; for 600 to 1,000 lbs. the furnace is arranged with burner and combustion chamber each side. The advantages claimed for this furnace are that in the event of a crucible leaking or breaking the melting can be continued in the body of the furnace; a very small area of metal is exposed during melting, which reduces oxidation to a minimum. Result of tests on 500-lb. size furnaces after the first heat have shown:—Gunmetal, 1½ hours; brass, 1 hour. The blast pressure required is 14 in. to 16 in. water gauge, which is very low. The furnaces can also be arranged for gas firing.

Fig. 5 shows the Monometer air-blast gas-fired crucible furnace, the special features of this furnace being:—The top box with two inlets forms a gas-distributing chamber; the bottom box performs a similar function in connection with the air, and takes up the pulsations from the blower after the cocks are adjusted; the chambers regulate the mixture so that the best results are obtained. The blast pressure required is 4 lbs.

Fig. 6 is Wright's 600-lbs. lip-axis gas-heated crucible furnace, arranged with constant pouring point. Inquiries have elicited the opinion that high-pressure gas is as economical as air blast up to 120-lbs. furnaces; over 120-lbs. size, owing to the larger amount of air required to give perfect combustion, air-blast furnaces are more suitable. For melting brass the gas consumption is about 4½ cub. ft. per lb. of metal melted. Increased speed of melting and reduced gas consumption can be obtained with air blast, but it has a damaging effect upon the furnace lining, which often only lasts three months; and the life of crucibles is also reduced. Six 50-lbs. high-pressure gas furnaces melting brass and gunmetal have been in use three years without re-lining.

Fig. 7 is the Hermansen recuperative melting furnace for six 250-lbs. crucibles. Fifteen heats of 70/30 brass can be melted in this furnace every 24 hours, which equals about 7 tons of metal. The makers claim that this furnace reduces fuel consumption 25 per cent, and that the life of the crucibles is about 25 per cent. to 35 per cent. longer than the ordinary coke-fired furnace. Fig. 8 is a sectional view of the furnace. The metal is melted in a reducing atmosphere, which reduces oxidation and brings the losses down to a minimum. The furnace can be worked with natural draught with a suitable chimney, or forced draught with 2-in. water-gauge blast pressure. These furnaces raise sufficient heat to melt steel. Fig. 9 shows the fire-clay air-bricks for recuperator.

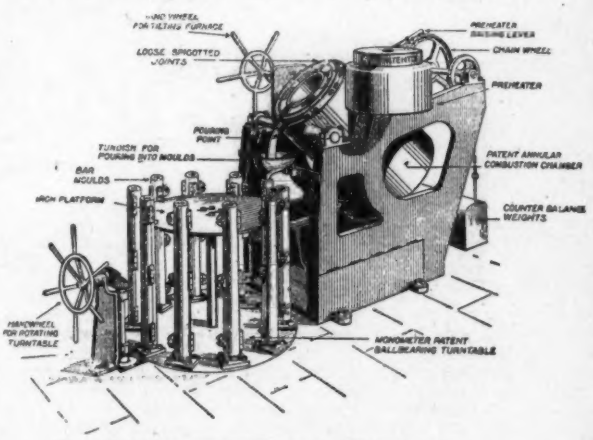


FIG. 2.—MONOMETER FURNACE WORKING IN CONJUNCTION WITH TURNTABLE.

Fig. 10 is a reverberatory furnace with Hermansen's recuperator. The coal consumption is 4 to 6 per cent per ton of metal melted. These furnaces can be built from ¾ ton to 20 tons and upwards.

Fluxes.

For copper and bronzes, phosphorus is the best flux. Powdered charcoal, as previously mentioned,

also assists in clearing the top of the metal of dross and oxides. For brass 4 parts salt and 1 part soda will be found a good flux.

For running down swarf and scrap, the following figures of losses will be found useful:—Swarf, clean and dry, 10 per cent.; swarf, wet and dirty, 21 per cent.; briquette, 10 per cent.; sheet scrap, heavy and light bundles, 4 per cent.; ingot from copper and spelter, 1.5 per cent. Wet swarf contains 5 per cent. of moisture.

Discussion.

Mr. C. M. Walter (Head of the Birmingham Corporation Laboratory) said that he thought they would all agree that when looking at the melting of metal purely from a cost point of view the coke-fired furnace would probably come out on top. If that were the case with the coke furnace in its present state, how much more would it be so when they began to use regenerative-type furnaces? In metal melting processes other factors of the melting cost, such as metal loss, had to be carefully considered. They had to consider the question of spilling, and the recovery of metal from ashes was an expensive process. In the case of a gas-fired furnace they had a simple means of recovering the bulk of the metal which might be spilt into the furnace. They also had the further advantage that the maintenance of the furnaces in regard to keeping them clear of slag and clinker was in the case of a gas-fired furnace entirely removed. It was generally found that when melting in a properly designed gas furnace, the total metal loss was less than in the case of coke, and the value of the metal so saved was that of the raw material plus the labour expended on it. Another point in favour of gas was that the melting temperatures were under the complete control of the operator. As Mr. Reason had pointed out, however, they had to pay for

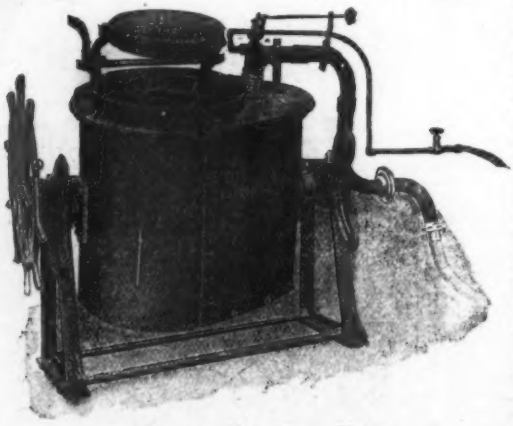


Fig. 2.—"Empire" Oil-fired Furnace.

the advantages of high temperature and the consequent increased rapidity of melting by the extra cost involved of keeping the linings in a good state of repair. His own experience in that connection was that there was a certain point beyond which any reduction in the fuel cost of melting due to increased temperatures and hence greater speed of melting was more than outweighed by the increased costs of maintaining the furnace linings in an efficient condition. In the case of gas furnaces up to 160 lbs. capacity, this point was usually reached with a gas consumption of approximately 4½ cub. ft. per lb. metal melted in the case of 70/30 metal. He knew of two instances where, in his department, they had been able to melt such metal at as low a figure as 1¾ cub. ft. of gas per lb. But in these cases the furnace linings lasted only one day. Of course

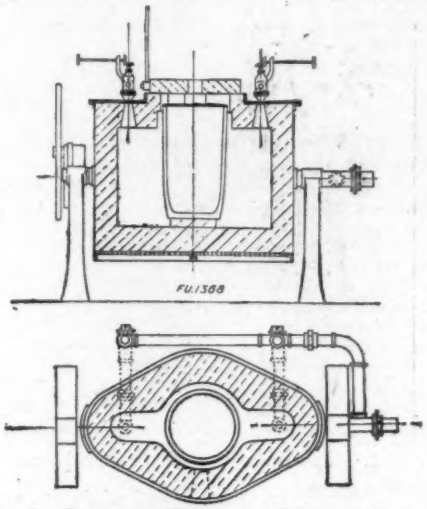


Fig. 4.—Sectional View of "Empire" Furnace.

that was quite impracticable from a commercial point of view. They were all anxious to make use of that class of fuel which, from the national point of view, was the most economical. Speaking generally, no one could say whether gas, coke, or oil was the most economical form of fuel for melting purposes, each form of fuel having its particular advantage according to the particular process of melting and the conditions obtaining; and the most suitable form of fuel for a particular process could only be determined by taking all these factors into account.

Mr. E. C. Hill (Rowland Hill & Sons, Limited, Coventry), referred to his experience in melting aluminium alloys. Mr. Reason had given illustrations of two or three patented types of furnace bottoms, which, he said, owing to the greater amount of air admitted to the furnace, gave a higher efficiency. It appeared to the speaker that any contrivance of that kind was really nothing but a makeshift designed with the object of raising the efficiency of the old pit type of coke furnace, which was simply a square brick box, with a few firebars in the bottom, to obviate scrapping those furnaces, and to avoid putting in new furnaces of better design. The Carr furnace shown on the screen seemed to illustrate Mr. Reason's arguments with regard to the access of a greater amount of air through the bottom of the furnace. He had tried the Carr furnace and the old type pit furnace without any special bottom and also the latter with the Wigley type bottom fitted. With regard to one type of these furnace bottoms, he noticed on the screen that there were four flat bars with wide flat surfaces exposed to the fire and the usual narrow slots to admit the air. This seemed to him a mistake,

but there might be reasons for it in the class of work under discussion. He preferred narrower firebars and a greater number of air slots. The increased number of slots kept the firebars cooler and thus prolonged their life. He had had a Carr furnace working continuously for three years, and found the firebars lasted very well and did not require to be frequently replaced. In working a

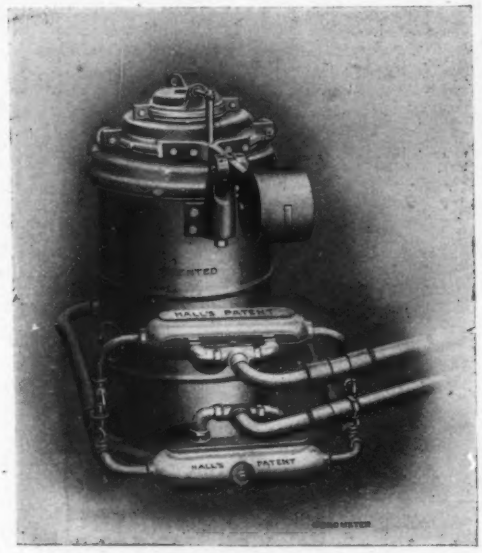


FIG. 5.—MONOMETER AIR-BLAST GAS-FIRED CRUCIBLE FURNACE.

gas furnace with plumbago crucibles up to 650 lbs. (copper standard), he had been able to obtain from 90 to 110 melts per crucible. That figure was taken over three separate months' working, and was continuously maintained. He noticed in one of the oil furnaces shown a very good feature, namely, that the top of the crucible was practically joined to the top of the furnace. That seemed to him a very good point, because thereby the surface of the metal was entirely prevented from coming into contact with the burning gases inside the furnace. It had often occurred to him that if other furnaces were designed with a similar object in view the oxidation of the metal would be very largely prevented. He did not know whether or not the increased cost of the crucible would be out of proportion to the advantage gained. There would probably be required a taller crucible in the furnace, as the upper part would not be so well heated, so that otherwise the capacity would be reduced, and probably the increased cost of the taller crucible would have to be put against the saving effected by reducing the oxidation. He had used burners of the Wright type in high-pressure gas furnaces of the pit type and used them regularly. As was shown in the illustration, the two-burner nozzles passed the gas through a double air-cone made of fireclay and designed to ensure that the amount of air which passed into the furnace should be in correct proportion to the gas. Mr. Reason said that the advantage of these burners was that when once they were properly adjusted, and the distance from the nozzles to the cone had been found to be correct, there was no occasion to do anything further with them. That was correct with regard to the adjustment of the nozzle, but the difficulty he found was that the air-cone burned away from the inside very rapidly and cracked, so that the cone had to be very frequently replaced and the burners readjusted. Therefore he had designed and brought into use a firebrick block with the cones formed in it. Thus the cone was very much better protected from the action of the fire and was much more durable. The cone formed part of a block of firebrock 18 in. or 24 in. tall and about 12 in. wide, and he found that this would last with continuous daily work from six to nine months. With regard to the Hermansen furnace, he had not been able to find that anybody in England had had any experience of it. He understood that it was designed for using coal as a fuel. When he made inquiries as to where he could see the furnace at work, he was informed that the nearest place was Sweden. If there were any in use in England or Scotland he would be very glad to know. There was no doubt that a gas furnace required less labour in working than did a coke furnace, so that the labour cost was a factor which must be brought in when making comparisons. In making comparisons between coke-fired and gas-fired furnaces, it might be said that the coke furnace came out a bit less with regard to efficiency generally, whilst if the gas furnace had an increased cost of melting, there were other things to be considered. All these things should be considered first and not put on as an afterthought. For example, how many of them took into account the cost of handling the coke before it got to the furnace? The gas came through a pipe and was delivered right into the furnace without any labour whatever. The coke had to be brought by rail, then hauled from the railway to the foundry, often over a con-

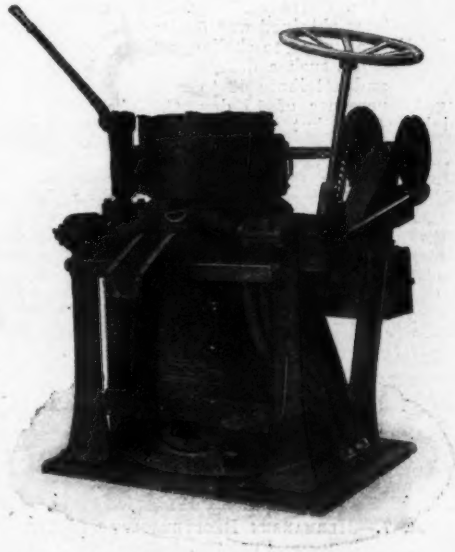


FIG. 6.—WRIGHT'S 600 LBS. GAS-FIRED CRUCIBLE FURNACE.

siderable distance, though at various large works which had sidings it was delivered on the truck. It then had to be moved to the furnace or per-

haps first to a coke heap in the yard, and it had to be handled, perhaps two or three times, by labourers before it got to the furnace mouth, where it had to be put in by the furnace man and his assistants. All that, as well as the cost of handling the ashes, must be added to the costs of the coke furnace.

Mr. F. Johnson (Head of the Metallurgical Department, Birmingham Technical School) remarked that Mr. Reason had referred to charcoal as a flux. He would like to ask Mr. Reason to reconsider the use of that term. In melting metals three agents were used, reducing agents, fluxes and deoxidisers; and charcoal was to be classed rather as a reducing agent than as a flux. Mr. Reason had drawn their attention to the oxidation which took place in connection with the melting of metals. Oxidation was brought about in at least two ways. It occurred during the melting-down period, and also when the metal had already melted. It was through oxidation during melting that the most detrimental results were caused. Mr. Dewrance, in a Paper read to the parent Institute some years ago, drew attention to the comparative immunity from deterioration in properties which Admiralty gunmetal enjoyed even when exposed to the furnace atmosphere for a considerable period. Alloys containing zinc which had been melted and exposed to the furnace atmosphere did not exhibit any very serious defects from oxidation. It was in melting down the constituent metals and exposing those metals to oxidation that the greatest trouble was likely to accrue. The table shown by Mr. Reason representing the results obtained by Longmuir in pouring metals at various temperatures showed in one case extraordinary results. In the melting down of red brass, Longmuir gave a pouring temperature of 1,073 deg. C., maximum tensile stress 12.65, and elongation 26, whilst with a pouring temperature of 1,053 deg. C. (only 15 deg. lower) the maximum tensile stress obtained was 5.67 and the elongation 5.5. He was going to challenge those results. One could not get such a difference in mechanical properties and attribute it to a difference in pouring temperature of 15 deg. C. The test results might stand, but the pouring temperatures as

Fig. 7.—Hermansen Recuperative Crucible Furnace.

given could not be held responsible. With regard to the comparative merits of square and round furnaces, Mr. Reason did not draw their attention to the difference in the cost of the bricks for the linings. He took it that the special bricks required for round furnaces were more costly than the ordinary bricks used in square furnaces. The loss of metal in the ashes in coke-fired furnaces had been mentioned by Mr. Walter. As casters' ashes in the Birmingham district were very considerable in amount, it would be an excellent thing to have some co-operative system whereby all waste products, including casters' ashes and waste pickling solutions, could be treated at a central works. Manufacturers had some diffidence in erecting plant for dealing with their own waste products because of the insufficiency of those products to

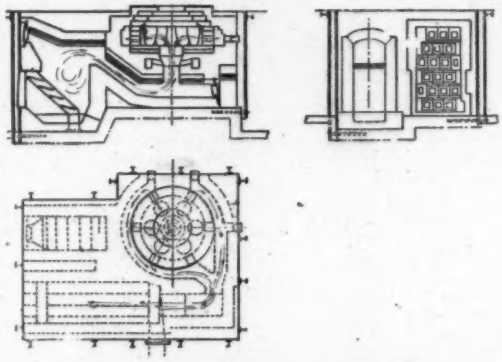


Fig. 8.—Sectional Views of Hermansen Furnace.

justify the initial expense. But if that objection of insufficiency were ruled out by the provision of a central works the material could be treated in a much more profitable way. With regard to the form of firebar used in one of the furnaces, Mr. Hill pointed out the undue breadth of the firebars in those furnace bottoms. He (Mr. Johnson) understood that it was very essential that the bottom of the crucible should be in the region of maximum temperature. On that account, perhaps, it was that the air slot was restricted in area so that the playing of cold air round the bottom of the crucible should not be excessive.

Mr. A. Spittle, while thanking Mr. Reason for his Paper, said that, like Mr. Johnson, he would also like to challenge the figures quoted from Mr. Percy Longmuir. He noticed that in Table II the melting point of yellow brass was given as 895 deg. C., while the pouring temperature of No. 6 was given as 850 deg., or 45 deg. below the melting point, and the melting point of gunmetal was given as 995 deg. C. while the pouring temperature as 965 deg. C., 30 deg. below the melting point. He did not think that was usual, even if possible, in general practice. Mr. Reason referred to the difference in operating costs between the round furnace and the square furnace of the ordinary open-type pattern. He (Mr. Spittle) noticed that Mr. Reason stated that in the circular furnace they must have 3 in. of coke space, whilst in the square furnace they had 1½ in. He himself thought it was possible to have a circular furnace with less than 2 in. of coke space—an ordinary furnace of 40 in. diameter. With a furnace of 15 in. diameter or one 15 in. square there was a difference of something like 12 per cent. in cross section, and in his experience the circular furnace was better and quicker, and in the matter

of repairs quite as cheap as the square furnace. A good deal of discussion had taken place with reference to the firebars in the "patent" bottoms. He thought it had been overlooked that the great feature claimed for these furnace bottoms was that they were constructed so that the air for the combustion of the fuel came up through the sides and not through the firebars at all, so that for all practical purposes the firebars need not be there. In fact, what actually took place, was that before the first melt was completed the firebars were slagged over and no air passed through them. The advantage claimed by the inventor for this type of furnace, an advantage which certainly had proved itself in practice, was that one could leave this clinker on the firebars and go on with the work without removing it, so that practically the whole of the fuel was doing a service. In the comparison given between oil and gas furnaces for melting no reference was made to the oxidising effects which took place in gas furnaces. That was a point which was worthy of serious consideration. To get the maximum effect of the gas one must use a flame which theoretically should be neutral but practically was oxidising. This had a very detrimental effect in the crucible. He believed that the similar effects from using oil were very much less, and that the life of

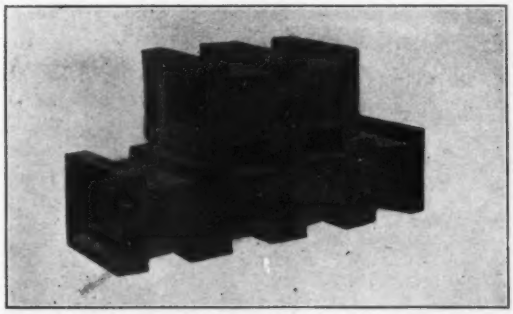


FIG. 9.—FIRE-CLAY AIR BRICKS FOR RECUPERATOR.

the pot in an oil-fired furnace was very much better. He was very glad to hear one of the speakers refer to the operating costs incidental to the use of coke. Such points as transport and handling were very generally overlooked, but they were of very serious moment in estimating the working costs of a coke-fired furnace. There was another point worthy of consideration. The coke was received in bulk and charged at so much per ton, but before it got to the furnace it had to be handled several times and dealt with by the coke-breaker, so that the weight when it got to the furnace was not the weight at the weighbridge. No such difference existed in using oil or gas, and every item in the labour cost of coke must be considered in the comparison. The metallic loss was another item of importance. There was a greater loss of metal into the coke, and then there was the cost of recovering it from the ashes; and it must be borne in mind that not all the shots that went into the coke could be recovered. At the present time a difference of 1 per cent. of metallic loss was an important matter, and if they were losing 3 per cent. with coke and only 2 per cent. with gas, the difference would be over £1 per ton in the losses when melting 70/30 brass. That was very important in considering the total cost of production.

MR. W. H. HENMAN was very much surprised to hear Mr. Reason say that in a gas-fired furnace there was usually a reducing atmosphere. His own experience indicated that generally in a gas furnace the atmosphere was oxidising. With regard to Mr. Hill's plan of using a firebrick block to which he attached the iron nozzle of the burner in a gas furnace, he (Mr. Henman) had tried that. The difficulty he found in using a firebrick block was that the flame got away between the nozzles of the burner and the block. They tried packing up with fireclay, but that was not absolutely effective, because from the pressure in the furnaces the flame came back and generally burnt the outside of the burner badly. With regard to the Edgar Hall and Wigley types of furnace, he had experienced trouble which he thought was due rather to the form of the furnace, because he found often that unless a man was careful to get his pot well up in the furnace with plenty of fire underneath he had a good deal of solid metal at the bottom of the pot, and that was very difficult to get rid of. When using that type of furnace the difficulty was to keep the pot off the bottom of the furnace, as the fuel under the bottom of the crucible burned away quickly. He noticed that Mr. Reason showed a gas furnace with a stack. His own experience of gas furnaces was that that was not usual; the furnaces he had used had no outlet at all, and there had been perfect combustion, so that there was nothing to be carried away. Mr. Reason gave them, he understood, the times of melting for a 600-lb. pot as 1¾ hours with gas and 40 minutes with oil. He did not see why oil should be so very much quicker in melting the metal. With reference to the life of a crucible in a gas furnace, most of the speakers said that it was less than with a coke-fired furnace. His experience had been exactly the opposite. The life of a pot in a gas furnace properly used was about three times that of one in a coke-fired furnace of corresponding size. He was speaking of gas at ordinary pressure with air blast. Turning from the Paper, he had a problem which he had been asked to bring before the members of the Section, and the solution of which, he thought, would be exceedingly useful to the general body of members. He exhibited two castings (2½-in. bars) from a 60/40 brass mixture which had developed very fine hair-like cracks, some of the cracks being scarcely perceptible. On inquiring from some of the members he was astonished to find that this was a very general thing, and he had not yet found any one who could give him what seemed to be the real explanation. They seemed to arise from a number of causes, and the difficulty at the present time was a very great one for manufacturers. The smaller piece had the cracks very marked, whilst the larger sample showed a very fine crack which was scarcely to be seen. The bars were 5 ft. long, 2½ in. diameter as cast, and drawn down to 2.4 in. Nearly all the cracks were horizontal, most of them running across where the mould joined. The dressing used was whale oil and charcoal, and the metal was covered with charcoal during melting. The mixture was two-thirds new metal and one-third scrap.

MR. F. C. A. H. LANTSBERRY commented upon Mr. Reason's remark that in a round furnace cutting of the pot resulted from high temperature owing to wear of the furnace wall at a particular point, and that the reason for it was that they got

an increased quantity of coke at that point. He (Mr. Lantsbery) asked whether that did not also apply to the square furnace? It appeared to him that there was likely to be an extra quantity of coke at the corners, and therefore a higher temperature at the corners. Had Mr. Reason ever known coke-fired brass-melting furnaces to be built on the same principles as the coke-fired furnaces used in steel making? He thought they might learn a good deal by applying in one industry the principles which had been observed in another. The crucible steel-melting furnace generally had a main vertical flue, which was continued below the level of the flue from the melting hole and opened into the ashpit. Control of the draught was effected from the ashpit opening. He would like to know whether a gas-fired reverberatory furnace had ever been used in this country for melting brass. At one time such furnaces were introduced for melting crucible steel, but they did not meet with much success, though why he did not know. With regard to electric furnaces he would also like to know whether induction furnaces had been used for melting brass or other non-ferrous alloys. Mr. Reason's figures for melting swarf showed that briquettes could be melted with a 10 per cent. loss, and scrap with a 4.5 per cent. loss. If the briquettes were properly made he was convinced that they would be melted with considerably lower loss than 10 per cent.

THE CHAIRMAN, referring to the samples which Mr. Henman had been asked to submit, said that he thought the cracks were probably due to a slight excess of copper. A great many of them did not realise that when they melted scrap they burned off considerably more of the spelter than when they were melting lumps of metal. There was a fin in the mould which got hold of the metal before it was properly set. These cracks occurred when there was anything more than 62 or 63 per cent. of copper, particularly if lead were present.

MR. H. PEMBERTON (Midland Railway Company), found that with a coke-fired pit furnace the time of melting was usually 70 minutes for 120 lbs. of metal using about 44 lbs. of coke, whilst the average life of the crucible in that case was about 27 heats. One man working three tilting furnaces, oil-fired, melted 600 lbs. in the same time, the fuel consumption being 0.97 gallons per 100 lbs. of metal melted, and the average life of the pot being 35 heats. They, however, used an air pressure much higher than any Mr. Reason had mentioned, the pressure being 20 to 25 lbs., which he had reason to think was too high. Probably if the air pressure were reduced they would get a much longer life of the pot. With a pit gas-fired furnace, of which they had a number at work, the average time of melting was about 75 minutes, the average life of the pot 28 heats, and the gas consumption worked out at 333.3 cub. ft. per 100 lbs. of metal melted. They also had a gas-fired tilting furnace with a pot of 600 lbs. capacity. The time there taken for melting was 90 minutes, and the average life of the tilting pot was 43.5 heats taken over a period of four months' working. With a tilting furnace and pot of larger capacity they found they could melt with 250 cub. ft. of gas per 100 lbs. against 333.3 cub. ft. with a pit-fired gas furnace. He assumed that the greater consumption of gas in the latter was due to the use of a smaller pot, 150 lbs. against 600 lbs. He had found that it was good practice to put the crucible on to the fire and allow it to be annealed and brought up to a blood-red heat. If that were done for one or two hours before charging with metal the pots would last much longer. This applied both to oil furnaces and gas furnaces. By bringing the pot up to a very excessive heat before putting in the metal a thin film of slag formed over the side of the pot, which acted as a preservative. Otherwise there was a danger of oxidation of the crucible. Some of the speakers had said that there was an oxidising flame in the gas-fired furnace. If that was so, he thought it was very detrimental. For melting non-ferrous metals in a gas furnace it was necessary to have a reducing flame. Copper, in particular, was a metal which very rapidly oxidised, and if this oxidation took place when the copper was in a pasty state, the oxide of copper, having almost the same specific gravity as copper itself, got mixed in the alloy, when the castings were made, with the result that the latter were not homogeneous. They got porous castings even under pressure, and he attributed that to the oxidation of the copper when it was in a pasty state. They found it really good practice, when they were going to melt virgin metal with scrap, to melt the scrap first. That, he was told, was against common practice, but they really got better results by melting the scrap metal first. It had been found, particularly in aeroplane work, with aluminium alloys, that the casting temperature had a very great influence on the physical

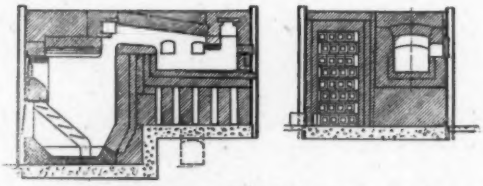


FIG. 10.—REVERBERATORY FURNACE WITH HERMANSEN RECUPERATOR.

properties, and he thought the same thing applied to phosphor bronze, which was a delicate metal and likely to be affected by any variation in the casting temperature. In the past the casting temperature had been chiefly judged with the eye, but he thought in future the casting temperature would have to be taken more carefully, as was already the case in making castings for aeroplane work. The flux he himself had used was chloride of zinc, and he found that very good for aluminium alloys. With reference to the samples which Mr. Henman had shown of 60/40 brass cast in a chill, he had had some experience with that, and he thought that the disease, if he might call it that, developed particularly after a new mould was made for the casting. He thought the trouble arose with the zinc. It was impossible to say how much zinc the iron took up out of the alloy, but he thought it would be found that the iron chill absorbed a great deal of zinc during the first eight, nine or dozen pourings. He thought they would find that they got better results when they used old moulds. He had had a great deal of this trouble. On pouring some cast iron in the same ingot moulds as used in the brass foundry, they first scoured them very carefully, but found a very thick film of zinc on the iron in spite of this preliminary cleaning, and this was observed several times. The oxide of zinc came out again and again between the iron and the chill.

MR. G. SMOUT (Elliott's Metal Company), com-

menting favourably on Mr. Walter's figure for gas consumption, namely, 4½ cub. ft. per lb. of metal melted, said that many men interested in gas furnaces spoiled their chance by mentioning a ridiculously low figure of consumption. He had heard the figure put as low as 2 and even 1½ cub. ft. That might be possible in trial tests carried out under strict scientific supervision, but he did not think that it could be done on a commercial scale, and certainly was impossible with any furnace that had to be left in charge of workmen. He considered 4 to 4½ cub. ft. a satisfactory figure on 70/30 brass to be poured into chills, using virgin copper, spelter, and the usual percentage of scrap, and including starting from the "cold" and the usual stand-by losses of time. Figures which did not take these factors into consideration were of no practical value. When considering the cost of gas against that of coke, the cost of compressing the air in the former case must be taken into consideration, since it was a serious item in the balance-sheet. In his opinion the future of the gas-fired furnace for metal melting lay rather in the low-pressure air-furnace than in the present type, where they had to work up to 3 to 3½ lbs. air pressure. If they could get a furnace working with low air pressure, which could be obtained by means of a fan instead of a compressor, he thought they would get much better results, and perhaps also get over their troubles with regard to oxidation. In his opinion, more oxidation was caused in gas-fired furnaces than in coke-fired furnaces, and he thought that anyone who had had to tackle the melting of gunmetal in gas-fired furnaces would suggest this view. Oxidation troubles could be overcome, of course, and perfectly good work turned out, but they were present, nevertheless. Mr. Walter had referred to the recovery of spilt metal from gas-fired furnaces, but Mr. Walter must not run away with the idea that shotted spilled metal from a gas-fired furnace could be got out and added direct to another heat. It was of very varied composition. For instance, if they were casting cartridge metal from gas-fired furnaces they would find the spilt and shotted metal not a homogeneous mass of 72/28 composition; it had to be run down and made uniform before it could be put back into the furnace; in fact, he would not use it in cartridge metal at all, but would reserve it for some inferior class of work. With regard to the table given by Mr. Reason embodying Mr. Longmuir's pouring temperatures, it was evident, as Mr. Spittle had said, that the pouring temperatures given were 50 to 70 deg. below the melting points as given by Gillett and Norton. Something was wrong, and he would like to know how Mr. Longmuir had obtained his pouring temperatures and the others their melting points, and what instruments they had used. With regard to the Wigley and the Hall furnace-bottoms, his experience had been that of others who had spoken, namely, that the Wigley bottom quickly slagged over the bars. That slag had either to be removed, which was not an easy matter during the running of the furnace, or they must depend solely upon the side ports for air. A great point in the successful working of these bottoms was to ensure that the side ports were kept free from clinker. If that were not done, the upper portion of the furnace-bottom would quickly overheat and wear out. He believed that the latest improvement in these bottoms was more bars and bigger air spaces. He understood that the patentee of one of the furnace-bottoms on the market had come to the conclusion that the flat wide bar was not the best, and was now putting narrower bars with wider spaces between. With regard to the comparative merits of round and square furnaces (natural draught), he thought the cost of the bricks should be taken into consideration, as well as fuel consumption figures, because in the round furnace the cost of the bricks was a much more serious item than in the square furnace, since in the latter any standard rectangular brick would answer.

MR. REASON, replying, said that the cost of losses in melting and in cartage of fuel varied in almost every instance, and depended a good deal upon the workmen and the supervision. There was a great variation in the cost of handling fuel. In some cases the fuel would be delivered to the foundry door; in other cases, a considerable amount of handling had to be done. With reference to the patent bottoms, he was quite sure they would be considerably improved by being fitted with loose fire-bars with increased air space between them. The slagging up would then be overcome and the burning away of the top plate would be almost negligible. As to the melting temperatures given by Gillett and Norton being higher than the casting temperatures given by Longmuir, he could not explain that. He thought it must be due to the pyrometer adjustment. When he mentioned coke space, he was referring to a 300-lb. size round furnace. For smaller furnaces the coke space would be reduced. For a 300-lb. square furnace only 1¼ in. space was required at the sides. With low-pressure burners, 1½ gallons of oil to 100 lbs. of metal was good practice, but with high-pressure burners the oil consumption could be brought down to 1 gallon per 100 lbs. of metal melted. He did not advocate high-pressure burners, as the large quantity of air that was blown into the furnace set up oxidation. That the metal was melted in a reducing atmosphere was one of the best points in melting with high-pressure gas. It was necessary to have properly designed chimney-stacks to remove the products of combustion and to regulate the furnace. Dampers were necessary in gas-fired furnaces, but they were seldom used in connection with coke-fired furnaces.

NON-FERROUS METALS INDUSTRY BILL.

The House of Commons on January 23 considered in the Report stage, the Non-Ferrous Metals Industry Bill.

The SOLICITOR-GENERAL moved an amendment giving a right of appeal to the High Court upon:—(1) The question whether a given business was or was not such as required a licence; (2) whether the conditions of the first schedule applied; (3) whether the applicant firm was controlled by a company, firm, or individual to whom the conditions applied; and (4) the Board of Trade's requirement for the production of books or documents for inspection. The amendment was agreed to.

Clause 3 provides for a penalty of three months' imprisonment, with or without hard labour, for trading contrary to the Bill, or a fine of £100 with imprisonment and fine for each day that the offence continues. The Government presented an amendment to make £100 the maximum and not the definitive fine. The Government's amendment was agreed to. A schedule sets forth certain firms and individuals to whom a licence should not be granted, as being or having been subjects of an enemy State, unless the Board of Trade considers it expedient.

British Foundrymen's Association.

SHEFFIELD BRANCH.

At a general meeting of the Sheffield Branch of the British Foundrymen's Association, held on December 14, a very interesting evening was spent in the discussion of various practical questions raised by the members. Mr. John Little (President) occupied the chair.

"Drawing Air" in Steel Casting.

MR. J. R. HYDE asked:—What happens when a casting draws air, and why should steel castings be more liable than iron to defects traceable to this cause?

MR. T. BROWN said he was not altogether clear as to what was meant by the question. When he was an ironfounder, which was some years ago, if a casting drew air it was supposed to cause a scab or something on the top of the mould, but he had never seen any defects in a steel casting through drawing air. He always looked upon it that the more air they could get off a steel casting, and the more open it was for the air and gases to get away, the more probability there was of getting a sound casting. In iron foundry practice it was the custom to fasten the riser down and to keep the runner full, but in steel foundry practice he did not think that was necessary at all.

MR. JOHN WATSON described an experience which he once had, and which he thought was due to the cause mentioned by the questioner. They had a number of ingots to make—long ingots, tapering almost to a point at the bottom—and they had to be made in silica sand. The job was run with a runner to the bottom. The ingot was parted off, and was apparently sound, but in the upper part, in a ring about two inches in from the edge, there were a series of white spots about an inch and a half apart. This trouble occurred in every ingot that was parted off and made that way, and the question was, what was causing those spots? Eventually, one of the ingots capsized, about five minutes after it was cast. It was quickly righted, to stop it bleeding from the head. When he cut the head off he found that where the spots were in the solid ingots, were holes. He split an ingot down through the centre of one of these holes, and found that there was a pipe right away down to just where the round of the ingot started. Each of these existed all round the ingot. He split quite a number of them, and in some cases, in turning the ingot back, this pipe had filled up, then came a hole, and then some more filling. The only conclusion he could come to was that, while the steel was running down the runner—which was a continuous runner right down, without any break in it—it carried with it a thin film of air, which in its passage down got very hot and in a state of pressure. When it got into the mould, the pressure was liberated: the thin film of air came to within an appreciable distance of the outside, where the steel was chilling, and then came up in a stream like the gas in a soda-water bottle when it was opened. In travelling that way, it acted like air being blown through a Bessemer converter, and produced a pipe of steel in the ingot which kept liquid after the surrounding steel had solidified. They examined the apparently solid ingots which did not capsize, and found that, right down the centre of each of the white spots, there was a pipe cavity, just like the pipe in the centre of an ingot, but not going all the way down. When they top-ran the ingot, the difficulty disappeared.

MR. HYDE said the circumstances dealt with in the question arose from taking a charge of, say, 30 cwts. of electrically-melted steel to pour into castings. In order to get the charge very hot, and to try to remove other difficulties, the orders were to pour the early moulds at "steady." In doing this, very often the runner was not kept up, and in consequence there was a distinct blow back, which the moulder termed "drawing air." He guessed it was bad practice, in the first case, not to keep the runner up, but still the idea was to pour slowly and so get the steel cool. The moulds were of sand, not absolutely bone dry but skin dry, and they found, in pouring that way, that the castings were liable to scabs, particularly on the top part. If there was any large area about the top surface—say the casting was up to 10 inches square, or 12 inches diameter—it was invariably scabbed on the top. Possibly, when they got back to iron-foundry experience, in casting a plate or anything of any large area, it was practically an example that they must keep the runner up or the top was sure to scab so badly as to be hopeless.

MR. WATSON suggested that the scabbing on the top part was due more to slowness in pouring, and allowing the heat radiated from the filling mould to destroy the top part and make the skin-dry portion curl up. They saw the same effect if they kept a mould too long after it had been moulded and dried before casting. The skin would come right off. He thought that was probably Mr. Hyde's trouble.

MR. BROWN did not agree with Mr. Watson's theory as to the steel carrying air with it. The steel, being much the heavier, would keep out the air from the atmosphere. There might be gases in the steel that were not liberated, and they would go with it. He thought Mr. Watson's trouble was due to the method of feeding.

MR. WATSON said the curious thing was that when they stopped running apparently the air stopped coming in. There was nothing drawn in, because the ingot was solid at the bottom. There was no sign of the defect in that part.

DR. W. H. HATFIELD said he did not think Mr. Hyde intended to run his moulds in the way he did. If he once allowed the stream to break, he was asking for trouble, so that he thought they might eliminate the actual data which gave rise to the question. He thought that in foundry practice every moulder knew that he must keep his gate up. At their foundry the moulder, from the gate ran into a spinner and kept the spinner full, so that all the dirt from the gate would flow on the top of the spinner. Thus it was obvious that if he once allowed his spinner to go down, not only would he be seeking other troubles probably such as Mr. Hyde experienced, but he would get the dirt into his casting which otherwise would keep in the spinner. With regard to Mr. Watson's explanation, he did not accede to it. Mr. Brown was quite correct. The mere fact that the runner was filled with metal made it very difficult for air to get in. He did not say air did not go in, but, if the defect were an elongated blowhole, it would have taken another shape. He rather thought that the case described by Mr. Watson was one of

pipe, pure and simple, although, on the scanty evidence before them, one could not give a definite decision.

Mr. W. J. Dawson thought it quite possible that Mr. Watson might be right in his contention. Supposing the stream was not a very full one, an action might take place by which the air was injected in the same way as the mercury of a vacuum pump, where the mercury fell down and caused a vacuum. He thought that, after they had conceded that, the rest of Mr. Watson's explanation was perfectly easy to understand. He wondered whether Mr. Watson analysed the steel in the vicinity of the defects, to see whether the carbon was somewhat low.

Mr. Watson said it was a nickel-chrome ingot—not ordinary carbon steel. There was another point that he might have mentioned. In these ingots the runner was continuous; but the runners in the iron-mould ingots ran in fours by a centre trumpet, were broken in lengths, and usually very badly jointed. He saw one runner that had had these bits of pipe knocked off, and at every joint there was a fin, and each of these fins were riddled with thousands of little holes. It struck him that the reason why the iron-moulded ingots did not show any of this fault was due to the fact that the air was getting out at each of these junctions, and that, by the time it got down to the bottom, there was no air left, because it was in such a finely-divided and high pressure state. He thought it was well understood in a steel foundry that if they had a very big flat top part they could overdo their risers by causing too big a speed of air going through them, and that also would cause the top of the casting to scab. He thought that proved Mr. Brown's contention.

"Snail Marks" on Steel Castings.

Mr. T. Brown presented the next question, as to the cause of "snail" marks on the outside of steel castings. These marks are invariably on heavy castings, running up the sides and generally out at the feeding heads.

Mr. Watson thought it was all a question of the density of the moulding sand. If they had a sand that would allow air or gas to vent through the spaces between the grains, they would not get that trouble. He had made, and seen made, very heavy castings in red French moulding sand, which was a silica sand, and had never found these marks on such castings, That sand, although it would stand up to the pressure all right, was much more open than ordinary moulders' composition. He thought the difficulty was purely a question of the air or gas not venting itself through the wall of the mould. The air inside, as the mould filled, became heated and attained much greater volume, and if it could not get through the wall of the mould from the inside to the outside, it came up the side of the casting. Probably the reason it did not appear on light castings was that the light skin cooled very much more rapidly and contracted quicker than a heavier casting, and the air had a space to travel.

Mr. Darley said that invariably these lines first began to appear when the casting was solidifying. A blue flame seemed to cut itself through. Both Mr. Brown and himself had watched it. They had seen sometimes that the contraction had left a gap of three-eighths of an inch between the casting and the sand, and still this flame would persist in coming close to the casting and cutting a course through. He remembered a case of a large container that they made. It was about a 30-ton casting, with walls about 15 inches thick, and the flame cut itself into that to the depth of about two inches, leaving a course as bright and smooth as glass. They always found that the part of the casting in the vicinity of these marks was practically the most solid of the whole. He had never yet seen a casting piped anywhere about there.

Dr. Hatfield asked Mr. Brown whether this trouble always happened when there was carbon in the refractory that he used for the mould. If he had no carbon present, did he get the same effect?

Mr. Brown replied that he should say there was always a certain amount of carbon in the composition. He agreed that they did not get the marks so much from silicious sand as from composition.

Mr. Watson, referring to the question of carbon, said at one time he could not make out why some of the castings which they were getting in the fettling shop were not only wormed but blown all over the outside—the skin all destroyed. He looked into the matter, and found that the man who made the "compo" was short of something and was grinding up coke and putting coke-dust in. As soon as that was stopped the trouble disappeared. He thought the contention was correct that very often it was the carbon content of the moulding sand that caused the trouble.

Mr. Brown said his experience of "snail" marks began about thirty years ago. He was then making some big rolls—ordinary rolls about 36 in. dia. They had joints in the mould, and the first casting had "snail" marks all the way up. In the case of the second one, through some mishap, a joint got broken. He had to go inside the mould, and while he was there he broke the joint away himself. When the casting came out, he was surprised to find that the marks only started from the next joint upwards. That suggested to him that air was getting in somehow. They then made every joint up, and after that the marks only started at the head. It was not always convenient to make up every joint. About five years ago they were making some large flywheels, 12 ft. dia.; when they came out they were all "snail" marked right up the outside. Walking round about two hours after the second one was cast, and after all the weights had been taken off the top part, he saw a big flame coming down the joint. Concluding that there was something causing that gas to come out there, he had sand shovelled in to stop the air from getting in. When that casting came out, there were no marks down it; they simply went up the head. Ever since then, wherever it had been possible to do it, he had always stopped the joints in order to keep the air from getting in, and he found it did away with the marks.

Mr. Watson said the removal of the "snail" mark was not always an unmixed blessing. He remembered once being very badly troubled with the mark in mill pinions. He spent about twelve months in trying to find a solution, and at last evolved a pinion that had no "snail" marks on it. When it was sent into the mill, the manager came over with a face like a red carrot. "What have you sent me over now?" he said. "Where are the holes that you used to cast in them? I have got nothing to keep the grease in?" (Laughter.)

Trouble with Steel Cylinder Castings.

ENGINEER-LIEUTENANT JACKSON, R.N., asked:—"Why is more difficulty experienced in casting a plain cylindrical pipe in steel—say, a knuckle or ball joint length of from ¼ in. to 1¼ in. in thickness and from 8 in. to 12 in. diameter—than in casting an intricate marine control valve or expansion piece in steel?" Often ball pipes which were used for steam pipes and expansion joints appeared on the surface to be good, but when sent to the machine shop they developed spongy parts. When put under pressure, they leaked. Sometimes they could be made satisfactory by electric welding, but in other cases when they were put under pressure again after welding other places showed signs of sponginess and they leaked in a fine spray. The pipe seemed a very simple thing to make. A turbine control valve, with four or five seatings in a valve box, was very intricate, but these were obtained perfectly sound? Another instance of sponginess that he remembered was that of some hydraulic rams for the steering gear of a man-of-war. They were cast, and there was a lot of difficulty in getting them to stand the pressure required, which was about 2,000 lbs. per sq. in.

MR. BROWN said his firm had done a lot of the work in question. The pipes were all machined on the outside, and, as soon as the pressure was put on inside, the water seemed to come through. He had cast them in all ways, and yet he had the difficulty. The castings weighed from 1½ to 2 cwt. They had the most trouble with those about 9 in. diameter and 4 ft. long.

MR. DARLEY said other firms were in difficulties with the same thing. They had been run with four or five runners, run in the bottom and in the top, lined up to gradually taper, and machined off, cast on the flat and on the end, and still they got the same trouble. He thought if anything those cast on the flat were the best. He did not think it possible to do anything more than had been done as regards trying to feed them.

MR. WATSON said apparently there were only two problems involved—feeding the job by risers and allowing the contraction to come on properly. If the contraction was stopped they would get a spongy substance. He would attack the problem from the standpoint of feeding of the job. He would put a series of denseners on the bottom side only, right round the casting, and a feeding head to feed the top side of the casting. At the same time, he would keep the narrower part of the mould as open as possible, so that no resistance to contraction could occur. It was not a question of the contraction cracking the casting. There was a point when the total contraction had not come on, and the metal was in a state of stress, giving an open structure. He had found the use of denseners, or chillers, the cure for a great deal of difficulty that apparently had not been curable.

MR. POLLARD said his firm had made the pipes two in a box, and had had one bad one and one good one. The spongy parts were not local at all, but showed themselves in castings made end on end the same as in those made at an angle and horizontal. With regard to Mr. Watson's remark on contraction, and keeping the mould open in the centre, perhaps where they had made a good one and a bad one in the same box they had had a little light ramming on one and heavy ramming on the other. That might explain it.

THE CHAIRMAN said some yeas ago they were casting 4-in. shell moulds, four in a box. They were cast on end, and were always spongy on the side opposite the other shell, as if the one affected the other. Around the other portion of the shell, which was exposed to the outside of the box, they were sound. The sides nearest to each other were always spongy, so that each was spongy on two strips. They put some such material as a piece of sheet iron between the two, and that got over the difficulty to some extent. The moulds were far better for it. Now, they were done with metal chills. The ones he had referred to were in compo.

A MEMBER:—I think the trouble was owing to the gases getting through the other one.

MR. WATSON:—I think the reason of the inside of the shell being bad was due to the fact that on the outside the heat was getting away very much faster through the wall of the mould and the compo., thus allowing them to solidify quickly and giving the same action as the densener I was speaking about.

It was finally agreed to adjourn the discussion, in order that a section of the casting might be produced, together with particulars as to where the risers were and other matters.

LONDON BRANCH.

Aluminium Chill Castings.

A meeting of the London Branch was held on Friday, January 18, Mr. J. Stone (Junior Vice-President) in the chair.

The Secretary expressed the regret of the Branch at the sudden death of Mr. W. Grout, who was to have read a paper on "Stamping Qualities of Copper-Zinc Alloys," and mentioned that a message of condolence had already been sent to Mrs. Grout.

An informal talk then took place, which resolved itself into a discussion on the value of giving care to casting and pouring temperatures.

Mr. Calliper exhibited a number of small chill castings of aluminium alloys with which he had had trouble from cracking. The castings were in the form of small discs about 1½ in. diameter, with a thin recessed centre, some having a composition of 7 per cent. copper, one spelter and one tin, and others 10 per cent. copper. The castings had to be released from the mould when red hot, but the experience was that as soon as they were got out they frequently cracked. It should be explained that the work is being carried out experimentally with the view to seeing the commercial possibilities, if any, of small parts cast in this way. The most reliable results, it was explained, had been obtained with 10 per cent. copper, yet exhaustive tests showed that the 7-1-1 mixture had the least contraction. Nevertheless, this latter had given the worst results from the cracking point of view. The crack did not always take place in the same way. The temperature of the chill was said to be 400 deg., although there were no means of ascertaining the precise figure. There was a runner and riser.

THE CHAIRMAN asked if it was necessary to have a runner and riser with such small castings.

MR. CALLIPER explained that he had experimented without a riser, with practically the same result, except that the casting did not run so well. The castings cracked. About 100 good ones had been obtained, but there were 500 or 600 bad ones.

MR. BARTLETT thought it was the centre part of the chill that was giving trouble.

It was explained that the chill was in two halves.

and that pouring had been done both quickly and slowly. Further experiments had been made in reducing the length of the runner and riser.

MR. BARTLETT suggested a runner on the top might give better results. In general practice, in running from the bottom, dull metal was being pushed up all the while, and the further it had to travel the duller it was. The longer the chill could be kept hot the less perceptible would the crack be.

MR. GAUNT said that firms making a practice of this class of work had tremendous runners. With 2-lb. castings he had seen runners on the mould of 2½ in. diameter. With an aluminium casting up to ¼-in. in green sand, run from the top, a good casting could not be obtained, owing to the troublesome nature of the aluminium skin that was formed. The same trouble was not experienced with gunmetal, even if pouring from the top was adopted. He never took an aluminium casting out until it was cold, and his firm had a pouring temperature for each job. Seeing that in this case a number of good castings had been produced, he felt that the difficulty was possibly due to the temperature of the metal, and if the temperatures were measured as the experiments were carried out, it should be possible to supply a range which would give a good casting, and that would solve the difficulty.

In the course of further discussion, it was remarked that continued use of the chill improved the results, and this might be a factor.

MR. GAUNT said that one method of keeping the casting temperature up was to have a series of moulds, which were put back into the muffle. Thus the moulds as they came from the muffle had a definite temperature.

MR. BARTLETT suggested that a smaller runner should effect an improvement.

MR. DAVIS asked whether chill casting was being carried out successfully commercially, and whether it was better than casting in the sand.

MR. GAUNT said it was being carried out successfully, but those who were doing it were not anxious to let others know how it was done. Such castings fetched a higher price. The advantage was that there was less machining to be done. The tensile strength of a chill casting was higher, and there was more elongation. The ordinary casting gave a carroty structure, which was brittle. With the chill method the structure was altered entirely to a crystalline structure. The structure was not actually closer, but it was one tending towards the interlocking of the crystals.

MR. BARTLETT said that tests given in a Birmingham paper last year had shown that it did not matter with 8 per cent copper how much the metal was overheated. So long as it was cooled down to the right temperature the right result was obtained. If the ideal casting temperature was 620 deg., it did not matter whether it was taken up to 900 deg., so long as it was cooled down to 620 deg. again and had not been oxidised.

MR. GAUNT said this question of temperature depended very much on the type of pyrometer used. A radiation pyrometer gave a lower reading than a thermo-couple inserted into the metal. The tests given in the Birmingham paper obtained with a thermo-couple were too low. It was necessary to use care in dealing with pyrometers, because there were variations, even when they were of the same type and from the same laboratory.

LIEUT. ALEXANDER HAYES pointed out that the Birmingham tests were with alloys containing about 10 per cent. zinc and much less copper, and would, therefore, have a lower temperature than aluminium-copper.

MR. GAUNT said that temperature in aluminium pouring was everything. Temperature in melting did not matter so much, as long as the metal was poured at the right casting temperature.

MR. BARTLETT said there must be a right casting temperature for everything, and, as in the case under discussion, satisfactory castings had been produced, the ideal condition of things would probably be found by experiment.

After a little further discussion, the meeting closed.

SCOTTISH BRANCH.

At a meeting of the Scottish Branch of the British Foundrymen's Association on January 12, Mr. Riddell, the Branch-President in the chair, Professor R. L. Mellanby, D.Sc., M.I.Mech.E., delivered a lecture on "Cast-Iron from an Engineer's Standpoint." He remarked at the outset that it would be greatly to the advantage of the engineer as well as the foundryman if more opportunities presented themselves whereby the engineer and the foundryman could meet and discuss with one another their particular difficulties. The progress of development in the engineering industry, the speaker continued, demands properties in cast-iron to withstand high and varying temperatures in the same casting and at the same time high pressures. Castings subjected to varying temperatures and high pressures demand properties in the metal which are most difficult to acquire. Uneven wearing properties and defective designing are other sources of worry. Many of the difficulties which at present engineers must face did not occur in ordinary steam-engine practice a few years ago.

The lecturer stated that greater efficiency can be obtained by the use of superheated steam than steam at its ordinary temperature, and gave as an example the use of superheated steam as applied to the turbine engine. This meant that castings for such work were subjected to very high temperatures. The internal combustion engine was another instance of castings subjected to high temperature and shock. The cylinder of a Diesel engine was a casting which gave the engineer much concern.

The production of a metal of a satisfactory structure was of immense importance and called not only for a knowledge of the constituents of the metal, but also the casting temperature and rate of cooling. The lecture was illustrated by a number of lantern slides showing photomicrograph views taken from parts of castings which had failed in the work for which they were intended.

CARBOHYDRATES AS STEEL DEOXIDISER.—A German patent recently issued in the United States describes a new method of deoxidising steel in the furnace bath. It is based on the addition of carbohydrates. Claim is made for complete deoxidation with only traces of carbon entering the bath. A special advantage is found in the production of a very soft iron. Sugar, starch, and cellulose are used with the best effect, though wood and herbaceous plants have been used with success, it is claimed. When sugar or starch is used 5.5 lbs. are sufficient to deoxidise completely a metric ton of steel. With wood shavings 9 to 11 lbs are necessary. Desulphurisation also is claimed to be accomplished by this process.

D

Burning Crude Oil.*

By W. A. Janssen.

There have been innumerable modifications of spray and jet burners. These may be divided into two classes, high pressure and low pressure types. Aside from the pressure of operation, they also vary in design and construction, depending upon the atomising agent used. These burners are dependent for their success on the use of air or steam as an atomising agent. In addition some burners

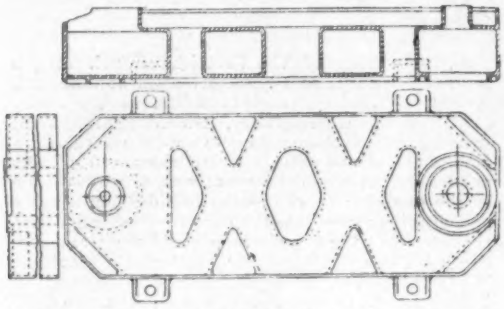


Fig. 1.—General Arrangement of the Cast-iron Preheater.

also have incorporated in their construction some form of spiral for mechanical atomisation.

The spray burner consists essentially of a fan-shaped spray of steam or compressed air upon which a stream of oil is allowed to trickle, the oil being diffused or atomised and burned. The jet burners, of which there are many types, are so constructed that a stream of oil is swept into and becomes a part of a stream of air or steam, being atomised therein and subsequently burned. The spray and jet types of burners have their limitations, because of their inability to maintain a positive adjustment of the definite amounts of oil and air necessary to assure and produce perfect combustion. This condition is further aggravated by the use of oils of variable specific gravity, which congeal in cold weather, making perfect combustion almost impossible without the almost constant attention of the furnace operator.

Because of the inability to properly control the air supply to definite combustion proportions, the quantity of air is usually in excess of theoretical requirements for complete combustion, causing a reduced flame temperature. In the spray and jet types of burners, it is essential that there be an abundance of air in order to assure complete atomisation and avoid smoking. If the burners are adjusted so as to admit a theoretical amount of air, the oil is not thoroughly atomised, resulting in imperfect combustion, accompanied by excessive smoking and attendant reduction in flame and furnace temperature. The great objection to the present methods of oil burning is that the vaporisation and combustion are practically simultaneous and that both occur within the combustion chamber.

During the past year there has been developed a system of oil burning wherein the oil, instead of being atomised or vaporised, is gasified in a specially designed vaporiser outside of the furnace. The gaseous product is forced into a combustion chamber under positive pressure, resulting in perfect combustion. This method of oil burning consists essentially of producing an oil-gas in a specially constructed vaporiser outside of the furnace proper, through the union of oil and heated air in definite proportions for perfect combustion. The air for combustion is delivered by a compressor at about 2 lbs. pressure and a velocity of 150 ft. per second. The air is forced to the vaporiser through cast-iron preheater boxes placed in the path of the out-going waste gases. With the admixture of oil in the vaporiser, a gaseous product is formed, which is delivered to the combustion chamber under continuous pressure.

The cast-iron preheater, Fig. 1, consists of a closed cast-iron box with openings to connecting boxes for the admission of incoming air. A series of vertical flues are provided to permit the passage of the outgoing waste gases through the apparatus, thus providing a source of heat for preheating the air for combustion. The number of preheaters required is dependent on the oil consumption for which the furnace is designed. They are stacked one over the other, and are so placed in the path of the outgoing gases that their walls will transmit the maximum amount of heat. Each heater is provided with an inlet and outlet opening for the admission of air. They are located on the opposite ends of the heater, necessitating a complete passage of air through the apparatus. As the heaters are stacked, the inlet opening of one connects with the outlet opening of another. With this arrangement the vertical flues are thrown out of line, thereby retarding the flow of the outgoing gases, permitting a greater heat absorption through the walls of the preheaters.

The vaporiser, Fig. 2, is a hollow cast-iron fitting. Its size is dependent on the calculated oil consumption. It has conveniently arranged inlet and outlet openings. Within the vaporiser are a

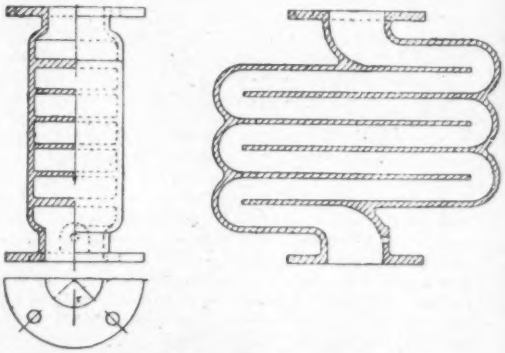


Fig. 2.—Two Sections of the Cast-iron Vaporiser.

series of baffles which form a winding zigzag path for the gaseous mixture of air and oil. The long winding passage is essential for complete gasification. The preheated air enters the inlet of the vaporiser and commingles with the oil stream. On striking the first baffle, gasification is begun. The mixture of air and oil gas then winds past the succeeding baffles. It finally is discharged from

* From Paper presented before American Foundrymen's Association, September 27, 1917.

the vaporiser through a pipe in the furnace wall leading to the combustion chamber.

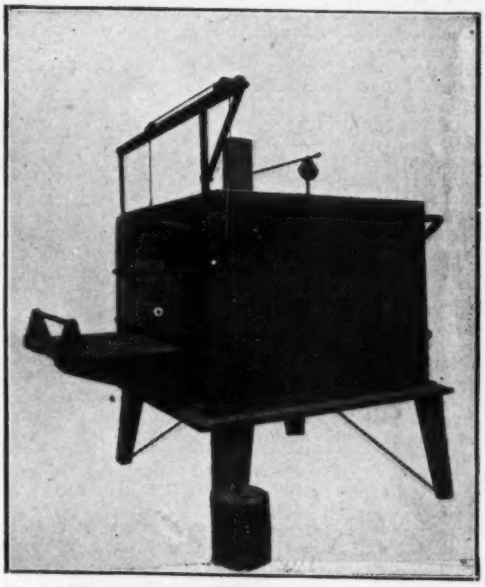
If perfect combustion is to be attained, the proportions of oil and air must be right and the temperature of the preheated air also must be correct. The installation operates most efficiently when the temperature of the air is about 800 deg. F. Allowing a temperature drop of about 100 deg. for radiation and the conversion of oil to gas, the net temperature of the gaseous mixture is about 700 deg. F. The velocity of the gaseous mixture should be about 150 ft. per second in order to prevent back-firing or flame propagation in the direction of the source. This is most essential, as the temperature of ignition, 1,050 deg. F., is only a few hundred degrees higher than the temperature of the gaseous mixture, which in the proximity of the heated combustion chamber almost instantly is brought to ignition temperature.

The heavy fuel oils of commerce are practically all of the following composition :—Carbon, 84.9 per cent.; hydrogen, 13.7 per cent., and oxygen, 1.4 per cent. The Baumé gravity is 26 deg. and the oil weighs 7.4 lbs. per gallon. For perfect combustion this necessitates about 3.4 lbs. of oxygen or 14.5 lbs. of air per lb. of oil. This is equivalent to 180 ft. of free air per lb. of oil, or about 1,500 cub. ft. of free air per gallon. This may be more easily expressed as 25 cub. ft. per minute per gallon per hour.

This method of oil burning lends itself very readily to every type of furnace in which the atomising types of burners have been used. Oil economies of 40 per cent. are not uncommon. A 10 per cent. economy alone is effected in the preheating of the combustion air.

Monometer Oil-Fired Oven Furnace.

A new type of oven furnace, heated by oil fuel, has recently been constructed by the Monometer Manufacturing Company, Limited, of Whitehouse Street, Aston, Birmingham, for case hardening. The aim of the company has been to produce a robust furnace capable of meeting rough usage and of high efficiency. The front and back plates of the furnace are of strong castings, made of a mixture of iron to suit the heat conditions, and the sides and top are built up of thick steel plates. The refractory material is of an exceptional thickness designed to minimise loss of heat, and the door is of the counter-balanced vertically sliding type, but the company have incorporated a special device for ensuring a tight joint between the face of the door and the adjacent face of the furnace front. If this detail is overlooked a large volume of heat escapes at this point. The wedge action effectually seals the joint, but does not prevent easy manipulation of the door. The well-known Monometer oil-fuel burner is fitted at the back of the furnace, and a special spreading arrangement is embodied to distribute uniformly the flame and heat below the floor of the furnace. A number of vertical flues convey the products of combustion from the chamber below the furnace floor into the heating chamber proper, the burnt gases finally making their exit through the top flue, which, it may be mentioned, is provided with a regulating indexed damper. The company's patent arrangement for pre-heating the air supply by passing it through metallic coils embedded in the brickwork ensures that the recuperative effect is taken full advantage of with a resultant great fuel economy and high heating efficiency. The makers state that the oil burner and combustion arrangements will consume all grades of fuel oil with perfect combustion and without smoke, and that the distribution of heat throughout the furnace interior is as uniform as can be desired, meeting the requirements of case hardening, etc., to an exceptionally satisfactory degree. The furnace is covered by patents of Mr. I. H. Hall, managing director of the company.



MONOMETER OIL-FIRED OVEN FURNACE.

ELECTRIC FURNACE FOR BRASS MELTING.—Mr. T. F. Baily, president of the Electric Furnace Company of America, of Cleveland, Ohio, recently described a resistance type furnace for melting brass and bronze. The furnace is of the non-crucible type and works on the true resistance principle. The furnace chamber is formed in a cylindrical shell, on trunnions and brackets for tilting. The bottom of the chamber is bowl shaped. The resistance element is contained in a circular trough made of a refractory material similar to carborundum fire sand. In this refractory trough the resistance material, composed of broken carbon, is placed, forming contact with the electrodes which are placed diametrically opposite each other with their ends protruding into the circular trough. The control of the current, and hence of the furnace temperature and melting capacity, is by means of suitable voltage taps brought out from the secondary coils of a special transformer supplied with each furnace. Running tests were given of melting bronze and brass, with mechanical tests of the cartridge brass produced and numerous analyses showing the uniformity of the metal at the beginning and end of the cast. The electrical power required shows favourable comparison as regards melting costs with crucible or open-flame melting furnaces, the average being 450 kw.-hr. per short (2,000-lb.) ton of bearing bronze, and 311 kw.-hr. per short ton of cartridge brass.

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Legal.

Taylor Brothers and Company v. Johnson.

In the Court of Appeal, before Lords Justices Pickford, Bankes, and Scrutton, on Friday last, the case of Taylor Bros. & Company, Limited, v. Axel Johnson, was heard upon the appeal of the plaintiffs from an order of Mr. Justice Avory, in Chambers, setting aside the writ and the proceedings in the action which had been instituted by the plaintiffs against the defendant, who traded as Axel Johnson & Company, at Stockholm, to recover damages for alleged breach of contract.

Counsel, in support of the appeal, said his clients were steel manufacturers in Leeds, and they made a contract in 1908 with the defendant for the supply of steel to them over a long period. The contract was now running, and would run until 1920. A great deal turned on the terms of the contract, and as to whether there was a breach of it within the jurisdiction so as to bring it within Order 11, Rule I. The action was started in this country, and leave was obtained to serve the defendant in Sweden. The only point taken before Mr. Justice Avory on behalf of the defendant was that the writ and proceedings should be set aside upon the ground that the alleged breach on which the action was based did not occur within the jurisdiction. Mr. Justice Avory upheld that contention. The contract was dated May 23, 1908, and set out that the plaintiffs would buy from the defendant all their requirements of Swedish pig-iron for their iron and steel works in Leeds and Manchester during the years 1908 to December 31, 1920, both inclusive, from the date of the contract, and that the defendant would sell the pig-iron upon the terms therein set out. By paragraph 2 the plaintiffs were to give to the defendant before July 1 in each year written notice of the number of tons of pig-iron required by them for each succeeding year; paragraph 3 set out that apart from their earlier requirements the plaintiffs would take in the year commencing January 1, 1911, and in each of the succeeding years a minimum quantity of 5,000 tons of pig-iron, but that the defendant should be under no obligation to deliver in any year from the date of the contract more than 12,000 tons of pig-iron. By paragraph 4 the defendant was to ship, upon the instructions of the plaintiffs, the said pig-iron for delivery at Manchester direct, or at Leeds, via Hull, the defendant to arrange for the shipment of the iron, the freight to be at the rate of 6s. per ton, and the basis of the rate from Hull to Leeds by canal to be calculated at a minimum rate of 3s. 9d. per ton. The plaintiffs, by paragraph 5, were to pay to the defendant a maximum price on a basis of 97s. 6d. per ton delivered in Leeds, or 93s. 9d. per ton delivered Manchester Docks. Paragraph 6 provided that the pig-iron should be at the risk and for the account of the plaintiffs from the time of the shipment. In addition to these paragraphs, added counsel, there was the fact as to the course of business between the parties. The documents were tendered to a bank in London, and were paid for by his clients there—that was the course of business, but it was not defined in the contract where the place of payment was to be made, and that was a necessary fact. The learned counsel read the affidavit of Mr. G. R. T. Taylor, the managing director of the plaintiff company, in which it was set out that the defendant had failed to supply to the plaintiffs all their requirements of Swedish pig-iron during 1908 up to December 31, 1920. It was a term of the contract that the delivery of the goods should be made in England. Defendants had failed to deliver any of the pig-iron in the year 1916, and by cable, dated May 12, 1916, refused to deliver a further supply. The breach of the contract on which the action was grounded occurred within the jurisdiction of the Court by reason of the fact that under the terms of the contract and the course of business between the parties all consignments of pig-iron were despatched by the defendant from Stockholm to Leeds, where delivery was made by the defendant. The learned counsel contended that upon the facts set out in the affidavit he had established a breach within the jurisdiction of the contract, which had to be performed here.

Mr. Le Quesne, on behalf of the respondents, supported the order of Mr. Justice Avory, and contended that plaintiffs' counsel had failed to show that the breach was one which was committed within the jurisdiction.

In the result their lordships adopted this view, and affirmed the decision of Mr. Justice Avory, and dismissed the appeal with costs.

Priority of War Manufactures.

The War Priorities Committee was appointed some time ago by the War Cabinet to decide questions of priority of manufacture in their bearing on the conduct of the war. The composition of the Committee is as under :—

Lieut.-General the Right Hon. J. C. Smuts, K.C., Chairman, the First Lord of the Admiralty, the Secretary of State for War, the Minister of Munitions, the Minister of National Service, and the Air Minister.

The Committee is assisted in the conduct of its work by a Permanent Sub-Committee, composed of representatives of the Admiralty, War Office, Ministry of Munitions, Air Ministry, and Ministry of National Service. The requirements for war purposes of the various Departments of the State are examined and co-ordinated by the War Priorities Committee, who decide the relative importance of their demands in accordance with the general rulings laid down by the War Cabinet, and arrange the allocation of the material resources and productive capacity of the country in the order of priority allotted. The War Priorities Committee performs its functions of allocation largely through the medium of Allocation Sub-Committees, composed of representatives of the various consuming departments concerned. Those Sub-Committees have been set up by the War Priorities Committee to investigate with regard to specific materials the supply available and the requirements of the several departments and public services, and to allocate supply in accordance with the general priority laid down by the War Priorities Committee. Differences of opinion occurring within these Sub-Committees will be referred for settlement to the War Priorities Committee. In addition, a Sub-Committee has been set up, which deals with works of construction, both public and private.

In order that the requirements of the public services, such as transport, light, heat, power, etc., may receive proper consderation, a General Services Committee has been appointed by the War Priorities Committee, under the chairmanship of Mr. John Wormald, M.Inst.C.E., with representatives from the Ministry of Munitions, Admiralty, War Office, Board of Trade, and Local Government Board. This committee considers the requirements of these services, and formulates on their behalf demands which are taken into account by the War Priorities Committee in their allocation of the available supplies of the various commodities. The chairman of this committee is assisted by an Advisory Committee, whose particular duty it is to inquire into the needs of the various general industries, the maintenance of which is not vital to the supply of war material or to the life of the community, but which it is desirable to preserve. The composition of this Advisory Committee is as under :—

Mr. George E. Alexander; Mr. Kenneth Chance; Sir Archibald Denny, Bart.; Mr. Alexander Walker; Mr. Henry Woodall, M.Inst.C.E.; a representative of the Board of Trade. The Secretary of the War Priorities Committee is Colonel F. J. Byrne, with offices at 11, Pall Mall, S.W. Applications for priority certificates and permits should continue to be sent to the Priority Departments of the Admiralty and Ministry of Munitions.

Deaths.

THE death is announced, at the age of 72 years, of Mr. Chas. A. Brown, of the firm of Huxham & Brown, engineers, Exeter.

MR. J. WRIGHT, for many years the London representative of Ashmore, Benson, Pease & Company, Limited, died last month.

THE death took place recently of Mr. Arthur Lee, late head of the firm of Arthur Lee & Sons, Limited, Crown Steel and Wire Mills, Sheffield.

MR. W. LEGER, the proprietor of the oldest ironfoundry in Retford, died rather suddenly at his residence last month at the age of 78.

THE death is reported, in his 77th year, of Mr. F. E. Duckham, a well-known engineer, who retired from active business about twelve years ago.

SEC. LIEUT. CROOKE, R.F.C., who was recently killed in an air collision, was a son of Mr. Walter Crooke, engineering manager of the Lilleshall Company, Limited.

THE death has occurred of Mr. J. Lawley, J.P., who, with his brother, Mr. W. Lawley, established the business of W. & J. Lawley, Britannia Foundry, West Bromwich, in 1881.

LIEUT.-COL. F. J. TRUMP, D.S.O., killed in action, was a son of the late Mr. H. V. Trump, who was at one time general manager of the Rhymney Iron Company, Limited.

MR. G. SMITH, J.P., senior managing director of the Smith & Grace Screw Boss Pulley Company, Limited, died recently at his residence, The Hollies, Thrapston, at the age of 76 years.

SEC.-LIEUT. A. W. H. PURNELL, R.G.A., who died as a prisoner of war in Belgium, was the eldest son of Mr. W. H. Purnell, a director of Herbert Morris, Limited, Loughborough

THE death occurred on January 15, at 1, Belmont Street, Glasgow, of Mr. T. Anderson, Royal Indian Marine, A.M.Inst.C.E., late Chief Inspector of Machinery H.M. Dockyards, Bombay and Calcutta.

MR. B. G. SMITH, who died at Halifax on January 12, in his 75th year, was the founder and head of the firm of B. G. Smith & Sons, brass founders, and lift and crane manufacturers, Stannard Works, Halifax.

MR. J. S. SELLON, of Johnson, Matthey & Company, assayers and refiners to the Bank of England and Royal Mint, died on January 18 at the age of 81 years. The business was founded by his uncle, Mr. P. N. Johnson, in 1822.

WE regret to learn of the death at Worthing of Mr. Sidney Steel, a director of Steel, Peech & Tozer, of Sheffield. Mr. Steel had been seriously ill for some years and unable to take any active part in business affairs.

DR. EUGENE FRANZ ROEBER, the founder and editor of "Metallurgical and Chemical Engineering," and also founder and past-president of the American Electro-Chemical Society, died recently at East Orange in the United States.

MR. CHARLES DAVIS, metal broker and merchant, 25, Rood Lane, E.C., died at his residence at New Malden, Surrey, recently, at the advanced age of 86 years. The deceased gentleman was known as the "Father" of the London Metal Exchange.

WE regret to announce the death of Mr. W. Grout, who occupied an important position in the works of Messrs. Geo. Kent, Limited, Luton. Mr. Grout was a member of the London Branch of the British Foundrymen's Association, and was to have read a paper last month before the Branch on "Stamping Qualities of Copper-Zinc Alloys."

MR. D. M. CUMMING, principal of the firm of D. M. Cumming & Company, Blackhill Shipyard, Glasgow, died very suddenly while on his way to the works. Mr. Cumming, who was 55 years of age, was a native of Glasgow, and a son of the founder of the firm. He was trained at the works, where he spent all his professional career, succeeding to the management in 1882.

MAJOR T. HERSCHELL JONES died on January 18, after a very short illness, at his residence, Whitmore, Eaton Grove, Swansea. Major Jones, who was about 57 years of age, started business as a metal merchant in Swansea a quarter of a century ago, and became an influential member of the Swansea Metal Exchange and the Swansea Chamber of Commerce, and he would shortly have become president of the latter body.

THE death took place on January 20, at the age of 89 years, of Sir Alexander Meadows Rendel, the eminent engineer. Sir Alexander, who was knighted in 1887, was a scholar and Wrangler of Trinity College, Cambs. He was appointed consulting engineer to the India Office and East India and other railways in 1874. His principal works include the shedwell of the new basin of the Royal Albert Dock, the Albert and Edinburgh Docks at Leith, the Workington Harbour and Docks, and the Sukker Bridge over the Indus.

SIR WILLIAM H. LINDLEY, the eminent civil engineer, died on December 30, at his residence at Putney, aged sixty-five years. He was the eldest son of the late Mr. W. Lindley, and from 1870 to 1873 he was his father's resident engineer on the Budapest Waterworks. He was next employed for twenty-two years as Engineer-in-Chief of the city of Frankfort-on-Main, and at the same time was consulting engineer for planning and carrying out various municipal works in other towns on the Continent, designing the new water supply of Petrograd from Lake Ladoga. Sir William was President of the Engineering Standards Commission of the German Gas and Waterworks Engineers, and Assistant Commissioner of the Royal Commission on Canals and Waterways in this country.

WE regret to announce the death, which took place on January 23 at Delahay House, Chelsea Embankment, of Sir John Wolfe-Barry, the eminent engineer, in his 82nd year. Sir John had been associated with some famous works, among which were the Tower Bridge, Kew Bridge, Barry Dock, the Surrey Commercial and Immingham Docks, and Natal Harbour. He was consulting engineer to several railway and other companies, and had sat on many Royal Commissions, while he was a member of the Court of Arbitration under the Metropolis Water Act. He had been a member of the Senate of the University of London, and a Governor of the Imperial College of Science and Technology, and was a past president of the Institution of Civil Engineers, as well as vice-president of the Institution of Mechanical Engineers.

Personal.

THE late T. A. Carpenter, engineer, of Brookside, Ilkley, left £24,307.

LORD FURNESS, upon whom the dignity of a Viscounty has been conferred, will be known as Viscount Furness.

SEC. LIEUT. B. H. PORTWAY, son of the late Mr. E. Portway, ironfounder, of Halstead, has been awarded the M.C.

THE gross value of the estate of the late Mr. T. Corbett, of the Perseverance Ironworks, Shrewsbury, is £54,421.

THE late Mr. B. G. Arkwright, a director of Sir W. G. Armstrong, Whitworth & Company, Limited, left £14,912.

THE gross value of the estate of the late Mr. J. Gray, formerly manager of the Tyne Lead Works, Hebburn, is £3,419.

THE late Mr. P. J. Harding, hardware and metal merchant, Long Lane, Borough, S.E., left estate valued at £57,258 gross.

ESTATE of the gross value of £97,863 has been left by the late Mr. J. W. A. Spencer, ironmaster, Woodside House, Coatbridge.

VICE-ADMIRAL SIR REGINALD H. S. BACON has been appointed by the Minister of Munitions as Controller of Munitions (Inventions Department).

CAPTAIN J. BENFIELD, A.O.D., mentioned in despatches, was, before the war, employed on the staff of Hadfields, Limited, East Hecla Works.

MAJOR B. CROWELL, who has been appointed Assistant Secretary of War in the United States, was formerly chief chemist of the Otis Steel Company.

CAPTAIN W. G. ORR, who has been wounded, is the second son of Mr. D. Orr, cashier of Andrew Barclay, Sons & Company, Limited, engineers, Kilmarnock.

MAJOR WALTER MACFARLANE, Yeomanry, who has been awarded the D.S.O., is the only son of Mr. Walter Macfarlane, of the Saracen Foundry, Glasgow.

MR. J. G. W. BELL, manager of the Pontoons Department, Smith's Dock Company, North Shields, has been appointed manager of the firm's undertaking at Southbank.

MR. H. M. THORNTON, the managing director of the Richmond Gas Stove and Meter Company, Limited, has been elected an associate of the Institution of Civil Engineers.

MR. C. F. SCHALL has retired from the firm of Strauss & Company, 16, Rood Lane, London, E.C. The business will be continued by Mr. Arthur Strauss, M.P., and Mr. H. Hilty.

LIEUT. F. S. SMITH, Royal Flying Corps, awarded the Albert Medal, is the son of Mr. A. Smith, of Alexander Smith & Sons, consulting engineers, 5, Newhall Street, Birmingham.

LIEUT. R. L. HUNTER, R.E., who has been awarded the Military Cross, is the fifth son of Mr. Summers Hunter, C.B.E., managing director of the North-Eastern Marine Engineering Company, Limited.

THE late Mr. T. D. Nicholls, of Caeglas, Skewen, for many years manager of the Cape Copper Company, Limited, of Briton Ferry, and previously engaged at the Morfa Copper Works, Landore, left estate of the gross value of £2,264, of which £1,985 is net personalty.

IT is understood that Mr. Harry Steel will be the chairman of the new Workington—Steel, Peech & Tozer—Frodingham—Fox merger. Sir John Randles, who will retire from the Workington Company, will leave the shareholders with a property which has very much appreciated in value.

MR. P. D. EWING, C.B.E., who has taken up the post of general manager of the Standard Shipbuilding and Engineering Company, Chepstow, is a member of the Institute of Naval Architects, a member of the council of the Institute of Engineers and Shipbuilders in Scotland, and a director of the National Physical Laboratory.

SIR GLYNN H. WEST has been released from his duties on the Munitions Council at the request of his previous firm, Sir W. G. Armstrong, Whitworth & Company, Limited, Newcastle, who are anxious to avail themselves of his services on the directorate. Sir Glynn West was appointed Deputy Director-General of Munitions Supply in 1915, Controller of Steel Manufacture in 1916, and Director-General of Shell and Gun Manufacture and a member of the Munitions Council in 1917.

THE lengthy list of New Year Honours contains a number of names familiar to readers of this Journal. Lord Furness, the new Viscount, is chairman of Furness, Withy & Company, Limited, and a director of the Weardale Steel, Broomhill Collieries, Easington Coal, Irvine's Shipbuilding, and Tees Furnace Companies. The Privy Councillors include Major Sir Henry Norman, Bart., a director of the Maltby Main, Rossington Main, and Sheepbridge Companies. Another baronet is Sir James W. Ritchie, a director of Milner's Safe Company, Limited. Appended are brief biographies of a few of the new Knights:—Mr. T. R. Marsden, managing director of Platt Brothers & Company, Limited, of Oldham, which firm has carried out many war contracts with great expedition and efficiency; Mr. G. Lunn, Lord Mayor of Newcastle, who has rendered excellent service in connection with the organisation of labour for the output of munitions; Mr. E. B. Phipps, lately general secretary to the Ministry of Munitions; and Mr. T. Putman, managing director of the Darlington Forge Company, Limited, Col. W. Charles Wright, director of Steel Production at the Ministry of Munitions, has been made a C.B., while Baron Nunburnholme, D.S.O., a director of Earle's Shipbuilding and Engineering Company, Limited, has received the honour of K.C.B.

Applications for Patents.

Aktiebolaget Svenska Kullagerfabriken. Hardening furnaces. 303. January 5. (Sweden, December 11, '16.)

Aktiebolaget Svenska Kullagerfabriken. Means for removing hardened annular bodies from hardening liquid. 304. January 5. (December 16, '16.)

Armstrong, Whitworth, & Company., Sir W. G., Trevelyan, F. B., and Rowden, W.C. Production of steel from scrap. 19,220. December 29.

Armstrong, Whitworth, & Company, Sir W. G., Trevelyan, F. B., and Rowden, W. C. Production of steel. 19,221. December 29

Askam, J. F. Tilting furnaces. 18,423. December 12.

Auld, J. P., and Tennick, P. M. Casting metals. 18986. December 21.

Bagley, C. H. F. Removing molten slag from open-hearth steel furnaces by air or steam blast. 747. January 12.

Brookfield, D., Gaunt, J., Tylor & Sons, J., and White, H. T. Furnaces for smelting and refining metallic swarf, etc. 803. 804. January 14.

Carroll, T. H. L., and Job, P. A. Production of a substitute for pig-iron, and its utilisation in steel manufacture. 18,554. December 14.

Chemical Engineering & Wilton's Patent Furnace Company. Furnaces. 530. January 9.

Donald, W. Open-hearth, etc., metallurgical furnaces, etc. 27. January 2.

Etchells, H. Steadying the arc discharge in electric furnaces. 1,012. January 18.

Greaves, H. A. Steadying the arc discharge in electric furnaces. 1,012. January 18.

Hardy, H. Flux for welding aluminium. 18,451. December 12

Lumsden, T., and Smith, J. Casting ingots. 18745. December 17.

Mead, A. Metallurgical heating-furnaces. 18719. December

Nicholls Company. Moulding machine. 19,330. December 31.

Pittevil, A. G. C. Welding different metals to form a composite ingot. 526. January 9.

Palmer, J. Process for production of basic steel. 162. January 3.

Richmond Gas Stove & Meter Company and Thompson, J. Steel furnaces. 276. January 5.

Rand, F. R., and Vautin, C. T. J. Aluminium alloy. 369. January 7.

Reynard, O. Method of treating iron and steel to prevent rusting. 572. January 10.

Soc. Francaise d'Exploitation de Fours Spéciaux à Haute Température. Furnaces for heating loupes, etc. 387. January 7. (France, August 28, '17.)

Thaberg, N. T. Producing gas from moist fuel in furnaces, gas-producers, etc. 18911. December 20. (Sweden, June 1, '15.)

Techno-Chemical Laboratories, Ltd. Furnace or heating chambers. 18,424. December 12.

Townsend, C. Preventative of rust in iron and steel. 18,431. December 12.

United States Alloys Corporation. Method of treating iron and steel. 19,313. December 31.

United States Alloys Corporation. Alloy of iron, titanium, and silicon, and process for production thereof. 19,314. December 31.

Walker, J. B. Process for manufacture of ingot moulds. 709. January 11. (United States, March 12, '17.)

Walker, J. B. Making ingot moulds. 710. January 11. (United States, March 12, '17.)

Watford Electric & Manufacturing Company, and Coates, H. Electric arc furnaces. 18876. December 19.

Whyte, S. Electric welding. 18,427. December 12.

Whyte, S. Manufacture of iron and steel and alloys thereof 18,428. December 12.

Whyte, S. Welding metals. 18,429. December 12.

Wood, C. C. Metallurgical heating-furnaces. 18719. December 17.

Trade Talk.

Mr. A. E. Dunstan, iron and metal merchant, has removed to 459, Queen's Road, Sheffield.

Ledward & Beckett, Limited, have removed to King's House, King Street, London, E.C.2.

Neil McNeil & Company, Limited, iron merchants, have removed to 86, St. Vincent Street, Glasgow.

The Sheffield Twist Drill & Steel Company, Limited, have removed to Suffolk House, 5, Laurence Pountney Hill, E.C.4.

The premises of the Murray Foundry Company, Limited, Lower Road, Rotherhithe, have been seriously damaged by fire.

Engineering Supplies, Limited, have removed from 28, Victoria Street, S.W., to Suffolk House, 5, Laurence Pountney Hill, London, E.C.4.

Bowes-Scott & Western, Limited, Broadway Chambers, Westminster, S.W.1, have removed to King's House, King Street, London, E.C.2.

The Anchor Metal Works, Limited, are being wound up voluntarily, with Mr. T. D. Neal, 110, Edmund Street, Birmingham, as liquidator.

Preliminary operations have been started on the construction of a new shipbuilding yard at Musgrave Channel, Belfast, for Messrs. Harland & Wolff.

The business of Messrs. Siemens Brothers has been sold by the Public Trustee. We understand that the purchasers include Mr. Birch Crisp and Sir Clifford Cory.

The Hamworthy Engineering Company have started the production of the semi-rotary type of pump, which, previous to the war, was almost exclusively of German make.

A fire broke out at the works of Messrs. A. Cohen & Company, metal manufacturers, Wild's Rents, Bermondsey, London, S.E., two buildings being destroyed.

Messrs. C. F. Palmer & W. Faraday, engineers, etc., Crownstone Road Engineering Works, Brixton, S.W., trading under the style of C. F. Palmer & Company, have dissolved partnership.

Rumours were current last month of an impending deal, in the nature of a combination, between Vickers, Limited, and the British Westinghouse Electric and Manufacturing Company, Limited.

At a Privy Council at Buckingham Palace last month, the King signed a Proclamation prohibiting, except under licence from the Board of Trade, the importation of various kinds of antimony.

Messrs. O. Kaiser and C. J. Pead, engineers' supplies merchants, 165, Queen Victoria Street, London, E.C., trading under the style of the Union Standard Machine Company, has dissolved partnership.

Messrs. G. E. Scott-Smith, J. Evans, and J. T. Stevenson, analytical and consulting chemists, 67 and 69, Surrey Street, Sheffield, trading under the style of A. H. Allen & Partners, have dissolved partnership.

Messrs. W. Kayley and J. Kayley, engineers and metal and machinery merchants, Star Ironworks, Pollard Street, Ancoats, Manchester, trading under the style of W. & J. Kayley, have dissolved partnership

Swan, Hunter & Wigham Richardson, Limited, have presented 800 of their veteran workers with War Bonds to the value of £10,000. The youngest veteran had twenty years' service and the oldest eighty-three years.

The shareholders of Hammond & Jones (Engineers), Limited, have agreed to place the company in voluntary liquidation. Mr. S. Lingard, 5, South Street, Finsbury, London, E.C., has been appointed liquidator.

It is officially announced that the wholesale price of calcium carbide is reduced to £35 per ton as from January 1. This price, however, is subject to alteration at any time, as may be directed by the Minister of Munitions.

The New Cransley Iron & Steel Company, Limited, is being wound up voluntarily for the purpose of reconstruction. Mr. H. J. Ellison, of Prince's Chambers, Corporation Street, Birmingham, has been appointed liquidator.

The Batts Foundry, Whitby, which has been idle for several years, but was previously occupied by Messrs. Robert Hulton & Sons, has been purchased from the owner, Lieut.-Col. R. D. Turton, by a locally formed company.

Mr. E. Ulrich, of 19, Bishopsgate, London, E.C.2, having severed his connection with Messrs. Bolling & Lowe, 2, Laurence Pountney Hill, London, E.C.4, has commenced business on his own account as iron and steel merchant.

An order has been made restoring the Letters Patent granted to Mr. J. Vaughan-Sherrin for an invention entitled "Process of and apparatus for making castings in steel, brass, phosphor bronze, and other materials," numbered 4,387, of 1911.

Steps are being taken for the amalgamation of the two firms of William Denny and Brothers, shipbuilders, and Denny & Company, engineers and boilermakers, as a private limited company under the name of William Denny and Brothers, Limited.

The partnership heretofore subsisting between Messrs. H. Taylor and S. H. Aizlewood, carrying on business as iron and steel merchants, at Imperial Buildings, Rotherham, under the style of Aizlewood & Taylor, has been dissolved.

The partnership heretofore subsisting between Messrs. E. W. Blake and W. J. Davy, carrying on business as engineers and manufacturing chemists, at 14, Rathbone Place, London, W.1, under the style of Blake & Davy, has been dissolved.

Mr. H. Norman Brooke and Mr. F. M. Brooke, directors of the Cleveland Magnesite and Refractory Company, Limited, have acquired the exclusive right to manufacture and sell Maccallum Metal-Kase brick in Great Britain. The firm are associated with Mr. B. Talbot.

The Health of Munition Workers Committee have prepared a handbook setting out briefly the steps which must be taken to maintain the health and efficiency of those employed in factories and workshops. It summarises many of the reports already published.

Messrs. H. Brearley, H. Brearley, W. A. Brearley, and S. W. Arnaud, mechanical and general engineers, Brandon, Suffolk, trading under the style of the Spartan Engine Company, have dissolved partnership, so far as regards Mr. Horace Brearley and Mr. S. W. Arnaud.

The council of the Institution of Civil Engineers has resolved that its examination in engineering, drawing, bills of quantities and elementary knowledge of specifications, which is at present an optional subject, shall be, after January 1, 1919, obligatory for all candidates for associate membership.

The partnership hitherto subsisting between Messrs. W. I. Johnson, 77, Havelock Street, Great Horton, Bradford, and S. E. Johnson, 77, Havelock Street, Great Horton, Bradford, carrying on business as engineers and pump manufacturers, at 155, Swan Arcade, Bradford, under the style of the Drum Engineering Company, has been dissolved.

The Board of Trade announce that it has been decided to postpone for a fortnight the opening of the British Industries Fairs to be held in London and Glasgow. It was originally intended that the Fairs should be opened on February 25, but according to the new arrangement the period during which they will remain open will extend from March 11 to 22.

Clause 5 of the Spelter Control Order of March 23, 1917, has been revised as follows:—"For the purpose of this Order the expression 'Spelter' shall mean spelter of all qualities, and shall include sheet and rolled zinc, scrap zinc, hard spelter, dross, zinc ashes, flux skimmings, zinc dust, zinc ore, zinc oxide, zinc sulphide (or lithopone), whether dry, in oil, or prepared for use, and zinc compounds of every kind, or any of them."

Mr. A. McMaster, lately of Messrs. Hamilton &

McMasters, Princes Docks, Belfast, has acquired the Central Wagon and Van Works, Tomb Street, Belfast, and after the necessary alterations intends to carry on the manufacture and repairs of marine engines and boilers, also general ship repairs. Mr. McMaster was for 22 years with the firm of MacIlwaine and Lewis (lately MacIlwaine & McColl), engineers and shipbuilders, Queen's Road, Belfast.

A FEW weeks ago a meeting of representatives of the commercial staffs connected with the shipbuilding, engineering and steel industries was held at Newcastle, when it was decided to form an organisation under the title of "The Shipbuilding, Engineering and Steel Commercial Staffs' Association," to improve the status and promote the interests of this profession. Mr. J. Mathieson, of Blackhill, has been elected president, and Mr. T. J. Ridley, of Monkseaton, and Mr. G. F. McGregor, of Walkerville, as vice-presidents.

MR. E. G. APPLEBY has converted his business into a private limited company for family reasons, and with a view to taking into partnership Mr. G. H. Bentley and Mr. W. E. Lee, who have for many years helped in the successful development of the business. The company will trade as E. G. Appleby & Company, Limited, and the business will be continued under the same management. The directors are Mr. E. G. Appleby, Mr. C. T. Appleby, Mr. G. H. Bentley, and Mr. W. E. Lee.

DR. ADDISON, M.P., Minister of Reconstruction, in addressing members of the British Institute of Social Service in the Grand Committee Room of the House of Commons (the Speaker presiding), last month referred to the subject of demobilisation, and said the Ministry was aiming at getting back first those who were immediately wanted, and men whose places had been kept open for them. It had been found that well over 50 per cent.—it might be 60 per cent.—had had their places kept open for them.

THE MINISTRY OF MUNITIONS are drawing the attention of their contractors and agents to the consequences of the system of restrictions on export and priority of orders which the United States Government is bringing into operation for the purposes of the war. The result of the system is that private firms desiring to secure export to this country from the United States of munitions or materials, to be used directly or indirectly in the manufacture of munitions, will find it increasingly difficult, if not impossible, to do so except either through, or with the direct assistance of, the Ministry of Munitions or other Government Department concerned.

Our Parliamentary correspondent is informed that in view of the agreement which has been arrived at between the Association of Chambers of Commerce of the United Kingdom, the Decimal Association, and the Institute of Bankers, it has been unanimously decided to introduce into Parliament a Bill embodying the reforms agreed upon in regard to the decimal coinage. Steps will, therefore, be taken to introduce such a measure as soon as possible after the re-assembling of the House of Commons. It is understood that Lord Balfour of Burleigh's Committee on after-war problems is likely to make an adverse report in regard to the adoption of such a scheme.

MR. VICTOR STOBIE, of the Stobie Steel Company, has purchased, for an extension to his Dunston-on-Tyne works, an adjoining works, which were built as recently as 1911 for the Bradley Williams Ore Treatment Company, Limited, passing from them into the hands of the Dunston Zinc Refining Company, Limited, from whom the works have recently been acquired by Mr. Stobie. The area of the property is some five acres, and the head offices of the Stobie Steel Company will be shortly transferred there. For the time being the works are being laid down to develop a new method of steel manufacture by the electric process, and it is also proposed to put down a rolling mill for rolling special steels.

THE Greaves-Etchell furnace has been adopted largely in the United States since it was introduced there last year. The Government of that country have ordered five of them, of large capacity, for their arsenals and dockyards, whilst other orders have been received from the Halcomb Steel Company, the National Radiator Company, the Singer Manufacturing Company, Ford Motor Company, the Stoddart Union Steel Company, the Primos Chemical Company, and others. The Ford Company will use their Greaves-Etchell's furnace to make castings for the celebrated "Liberty" aircraft motor. Three are on order for armament works in Spain, and one is being supplied to New Zealand for producing steel castings from scrap.

MESSRS. M'KIE & BAXTER, engineers, Govan, have been carrying out recently large extensions to their establishment in Copland Road. The works were started in a very small way 21 years ago, the original area being 3,000 square yards. By the successive increases which have been made, especially within recent years, the area has been extendd to 15,000 square yards. Early this year intervening works were taken over specially to assist in the construction of engines required for standard ships—six sets of which are at present under construction, as well as a large amount of other special work for the Admiralty. Still further ground has been acquired and additional extensions are to be made, so that the largest engines can be built and that the firm may start the construction of geared turbines.

A MEETING of the shareholders of William Cooper and Goode, Limited, will be held this month to approve an agreement for the sale of the undertaking and assets to Elliotts Metal Company, Limited. The terms of the sale are the issue of four £1 ordinary shares of Elliotts Metal Company in exchange for five £1 ordinary shares of William Cooper and Goode and one £10 five per cent. preference share of Elliotts Metal Company in exchange for ten £1 five per cent. preference shares of William Cooper and Goode. Mr. T. W. Horton, one of the directors of William Cooper and Goode, will join the board of Elliotts Metal Company. To preserve continuity, the business of William Cooper and Goode will be transferred to a new company of the same name, the whole of the share capital of which will be subscribed and held by Elliotts Metal Company or their nominees.

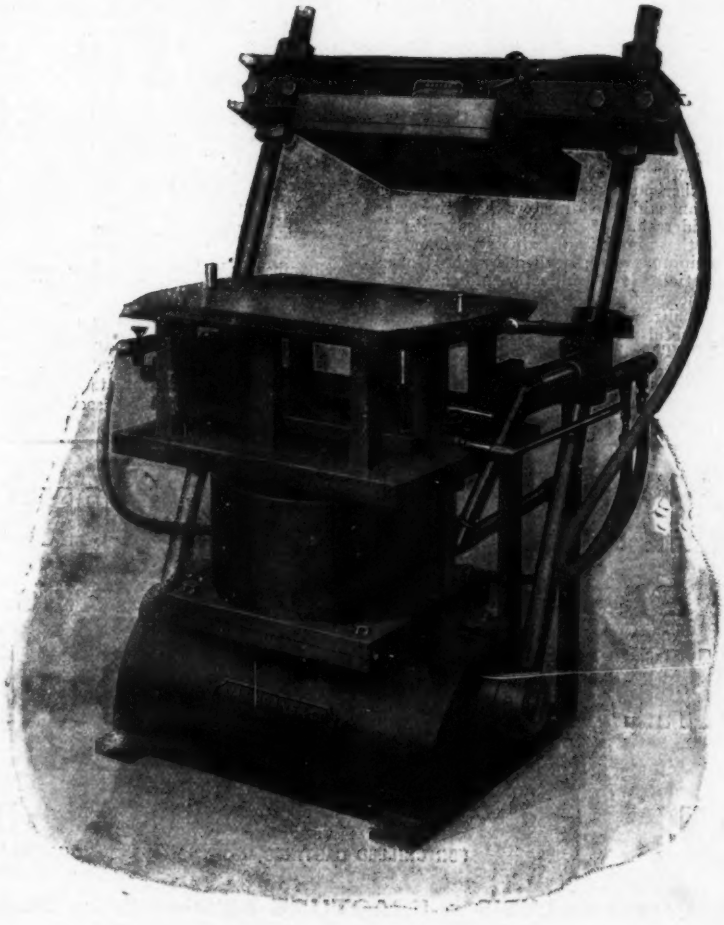
THE CONTROLLER OF NON-FERROUS METALS has informed the West of England and South Wales Iron, Metal, and Waste Trade Association that it is not necessary for small collectors of copper, brass, lead, and zinc scrap, other than that arising from the manufacture of munitions, to hold a special permit from the Ministry. The members of the Association, he wrote, are not only permitted, but should be encouraged to collect the utmost possible quantities of these materials. Copper and lead scrap may be sold by collectors to merchants, but under no circumstances may these materials be sold to consumers, who are only permitted to obtain their supplies direct from the Ministry. Yellow brass turnings and borings, no matter under what circumstances they arise, may not be dealt in, but miscellaneous, collected, and domestic brass scrap may be sold in the open market.

THE firm of J. Hopkinson & Company, Limited, Britannia Works, Huddersfield, which was founded in the year 1843 by Mr. Joseph Hopkinson, completes, as we have already mentioned, 75 years in 1918. The original works were situated in Fitzwilliam Street, the new Britannia Works being built in 1904. The total area now covered by the buildings exceeds 15 acres, including the recent extension steel foundry, laboratory, and test houses. The earliest of the safety boiler mountings was the compound safety valve for high steam and low water, originally patented in 1852. The modern "Dual" valve embodies the principle of the original compound valve, but many improvements in materials and details of construction have been introduced. The parallel slide blow-off valve has been a standard boiler fitting for over 50 years, and the number supplied exceeds 120,000. The "Hopkinson-Ferranti" patent steam stop valve was introduced by the firm, and over 30,000 have been manufactured in all sizes from 4 ins. to 24 ins.

MOULDING MACHINES

OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.



JAMES EVANS & CO., BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

Mr. W. J. Foster, of the Capponfield Blast Furnaces, Bilston, Staffs., writing in the "Daily Mail," states that in the matter of war material there is a tremendous waste so far as iron and steel are concerned, particularly in the manufacture of shells, which hitherto in this country have been made with steel, yet it has been known to the Government that cast iron could be used, giving a tensile strength of 20 tons to the square inch, shells of which could be made at a very rapid rate with a loss of not more than 10 per cent. from the actual casting. As it is, we have been making everything possible out of steel where a substitute might have been introduced, and now find ourselves short of steel, and also of cast iron. In the early stages of the war, and, indeed, up to the present, the production of pig-iron for castings generally has been greatly neglected, and our blast furnaces have not been built to turn out the extra tonnage to correspond with the German output. With careful supervision and good management on scientific lines our tonnage in this respect could very quickly be doubled at an expenditure of not more than £250,000 per day.

The shareholders of the British Aluminium Company, Limited, met last month for the purpose of considering a resolution empowering the company to construct waterworks and works for developing and generating power and other works, and to acquire lands, and for other purposes. In moving the resolution, the chairman said the directors had the necessity under consideration of keeping pace with the development of the aluminium industry. The production of aluminium was regarded by the Government as an essential "key" industry, of which their company were the pioneers in this country. It was the desire of the directors to endeavour to secure an extension of so useful an industry within the confines of Great Britain. They had been fortunate in finding what he believed to be the largest available water power in Great Britain, and all the more so as it was capable of development adjacent to their Kinlochleven factory, at present the largest hydro-electric station in the country. The economy resulting from concentration of production was obvious. The power available at Kinlochmore was estimated to be of approximately 60,000 horse-power, and the cost of the water power development was estimated by their engineers on a post-war basis at £1,594,876, to which had to be added the cost of the necessary factory and incidental expenditure. The resolution was carried.

Representative merchants from all parts of the kingdom met at Birmingham last month, for the promotion of a federation of their existing organisations for the more effective expression of their claims as an integral part of the trading system. Mr. Buchanan, chairman of the Metal Merchants' Section of the London Chamber of Commerce, presided, and said that the powers of the Government had been ruthlessly employed in opposition to the merchants' interests. No amateurs could possibly conduct the country's business. With the restrictions imposed upon them the merchants' income this year would not meet expenditure, but the loss of connection and goodwill was still more serious. On the motion of Mr. C. Wiggins (Middlesbrough), it was decided that meetings should be arranged of various merchants' organisations as a preliminary to federation. Mr. H. Flannagan (Manchester) moved a resolution which, whilst acquiescing in the control of imports and exports as a war measure, urged it should cease except with enemy countries and subjects at the earliest possible moment consistent with national interests. This was agreed to. The meeting was under the auspices of the London, Birmingham, and Sheffield Chambers of Commerce (Iron, Steel, and Metal Merchants Sections), North of England Association of Iron, Steel and Metal Merchants, South Wales Association of Iron, Steel, Tinplate and Metal Merchants, Metal Merchants' Associations of Manchester, Liverpool and Hull, Scottish Association of Iron and Steel Merchants, London Association of Tinplate Merchants, and the Edinburgh Iron Merchants' Association.

T. & I. BRADLEY & Sons, Ltd.,

DARLASTON, South Staffs.

SPECIAL COLD BLAST PIG IRONS.

Brands:

R.A.M. — FOR CYLINDERS.

IXL. C.B.R. — FOR CHILLED CASTINGS, &c.

D.M.R. — CHARCOAL FOR MALLEABLE CASTINGS, &c.

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ALL MINE.	WARM BLAST.	COLD BLAST.
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IF YOU HAVE DIFFICULTIES WITH YOUR SPECIAL CASTINGS CONSULT US.

We can put you right.

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PIG IRON.

Scotch, Middlesbro', Hematite, Basic, Specials, &c., &c.

STEEL.

Billets, Wire Rods, Tube Strip, &c.

REGISTERED TRADE MARK

COPPER.

Tough, Best Selected and Refined Ingots, Electrolytic Ingot Bars, Wire Bars, and Cathodes.

TIN.

All Brands Ingot and Bar Tin.

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G.O.B.'s and Special Purities.

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109, HOPE STREET, GLASGOW.

WILLIAM COLVIN & COMPANY,

MIDDLESBOROUGH AND GLASGOW.

New Companies.

Hayes Iron & Steel Company, Limited.—Capital £10,000 in £1 shares.

Midland Motor Cylinder (Aluminium), Limited.—Capital £10,000 in £1 shares.

Blane & Company, Limited.—Capital £100,000 in £1 shares, to carry on the business of shipbuilders.

American International Steel Corporation, Limited.—Capital £10,000 in £1 shares. Registered office: 26, Victoria Street, S.W.

Alderley Copper Company, Limited.—Capital £40,000 in £1 shares (19,000 "A" and 21,000 "B"). Registered office:—1, Gresham House, E.C.2.

Springthorpe, Limited.—Capital £2,000 in £1 shares, to take over the engineering business of W. H. Springthorpe, Devonshire Street, Winson Green, Birmingham.

Edward Lucas & Son, Limited.—Capital £25,000 in £1 shares, to enter into an agreement with T. H. Lucas and to carry on the business of ironfounders, etc.

General Engineering Company, Limited. — Capital £500 in £1 shares. The first directors are: R. Duxbury (managing director), D. Davy, and J. Fielding (chairman).

E. G. Appleby & Company, Limited.—Capital £30,000 in £1 shares, to take over the business of an engineer carried on at 12, Broadway, Westminster, by E. G. Appleby, as E. G. Appleby & Company.

British Expert Engineers and Precision Tool Manufacturers, Limited.—Capital £4,000 in 1,500 £1 preference, 390 £5 ordinary and 26 £25 founders' shares. Registered office:—22, Cross Street, Islington, N.

William McLean, Limited.—Capital £25,000 in £1 shares, to carry on the business of manufacturers of and dealers in steel, steel alloys, etc. Registered office:—14, Stirling Chambers, Camp Lane, Sheffield.

Wilson Brothers Pipe Fittings, Limited.—Capital £10,000 in £1 shares, (5,000 preference), to take over the business of Wilson Brothers, metal founders, engineers, etc. Registered office:—377, Dalmarnock Road, Glasgow.

St. Dunstans Syndicate, Limited.—Capital £5,000 in £1 shares, to carry on the business of ironmasters. The first directors are H. N. Knight, J.P., and F. L. Baldwin. Registered office: 19, St. Dunstans Hill, London, E.C.3.

New Cransley Iron & Steel Company, Limited.—Capital £100,000 in £1 shares, to take over the business carried on by a company of the same name (in liquidation). The first directors are E. C. Keay, A. T. Keen and J. F. Pearson.

Railless, Limited.—Capital £5,000 in £1 shares, to adopt an agreement with B. D. Fox, R. Freemen, A. Hoare and E. M. Monro, and to carry on the business of machinery manufacturers. Registered office: 273, Finsbury Pavement House, London, E.C.

Pyne, Hughman & Company, Limited.—Registered in Calcutta, to take over the engineering business of Pyne, Hughman & Company. Capital Rs.3,10,000, in 3,100 shares of Rs.100 each. British address: F. M. Short (manager in the U.K.), 329, High Holborn, W.C.

Wellington & Mackenzie, Limited.—Capital £2,000 in £1 shares, to take over the engineering business of Wellington & Company. The first directors are J. M. Wellington, D. G. Mackenzie, and J. R. Mackenzie. Registered office:—24, Empress Avenue, Ilford, Essex.

David Rowan & Company, Limited.—Capital £400,000 in £10 shares, to take over the business of D. Rowan & Company, marine engineers. The first directors are J. Lithgow, H. Lithgow, W. J. Weir, W. Tod, W. R. Thomson, and J. G. Young. Registered office:—231, Elliot Street, Glasgow.

Richmond & Wordsworth, Limited.—Capital £100 in £1 shares, to acquire any invention for smelting, refining, converting, manufacturing, and dealing with alloys, &c. The first directors are: J. H. Sayles, W. H. Gray, and T. E. England. Registered office: 38, Oxford Street, Sheffield.

The Mastery
SIROCCO
of the Air.
TRADE
SIROCCO
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FANS
SEND US YOUR ENQUIRIES FOR
are always successful in the struggle for the Mastery of the Air
Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.
Davidson & Co., Limited,
Sirocco Works, BELFAST.

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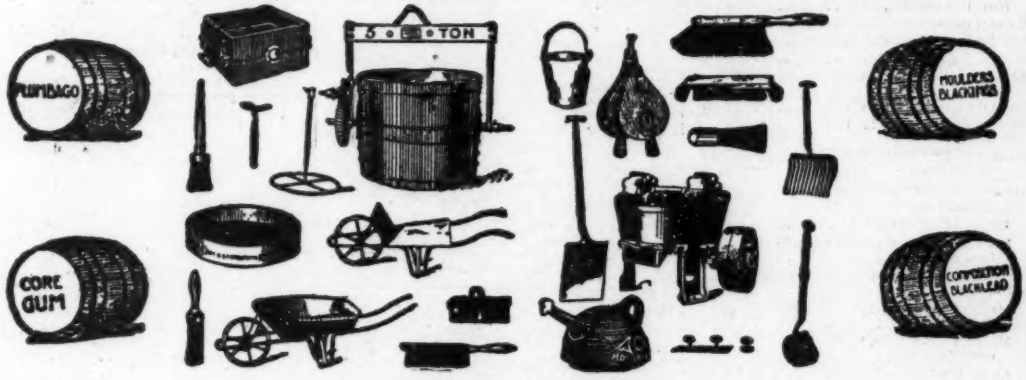
Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



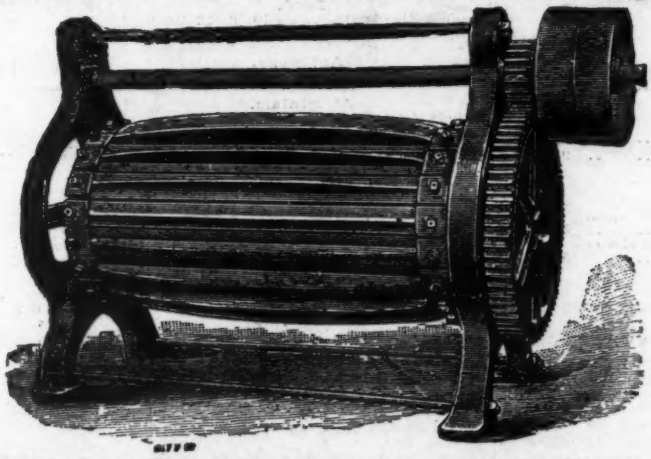
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos. 1, 2 and 3	6	7	6
Special under 0.03 P. & S.	6	15	6
" " 0.02 "	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S.	6	7	6
Special under 0.03 P & S.	6	15	6
" " 0.02 "	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	6	15	6
" " 0.02 "	7	0	0
HEMATITE—MALLEABLE— Refined—			
Refined Cupola Cast	8	0	0
Refined Cupola Cast to guaranteed analysis	8	5	0
Cast direct from Blast Furnaces—			
Small Pig-Iron, all grades	7	10	0
Medium Pig-Iron White to Grey mottled	7	5	0
Medium Pig-Iron, all other qualities	6	17	6
Large Pig-Iron, all grades	6	17	6
Lincolnshire, basic or foundry	4	17	6
Cleveland, No. 1	4	19	0
" other grades	4	15	0
" basic	5	0	0
Northamptonshire, forge	4	7	6
" fdy numbers	89/0		94/0
" basic	4	17	6
Derbyshire, forge	4	10	0
" foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge	4	10	0
" " foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
" " foundry	4	17	6
" " basic	4	17	6
South Staffordshire—			
Part mine forge	5	0	0
" foundry	5	2	6
Common Staffordshire	4	15	0
All mine forge	5	15	0
" foundry	6	0	0
Warm air forge	7	5	0
" foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Basic	4	17	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1¼%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 2s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings	5d.
Bar Ends	6d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton	—		
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	—		
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	—		
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	—		
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	—		
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit Per ton	—		
Ferro-titanium: 23/25%, per lb. carbonless	—		
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	—		
Ferro-phosphorus: 20/25%. Per ton	—		
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	—		
*Ferro-manganese 80%	26	10	0
" export	—		

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s.	d.	£	s.	d.
Standard, Cash	110	0	0	110	10	0
Three months	110	0	0	110	10	0
Electrolytic	125	0	0	121	0	0
Tough	123	0	0	119	0	0
Best selected	123	0	0	119	0	0

Tin.

Standard, Cash	298	10	0	299	0	0
" Three months	296	0	0	297	0	0
English Ingots				300	0	0
Bars			—	301	0	0
Refined			—			

Spelter.

American	54	0	0	50	0	0
Specials			—			
Hard	46	0	0	47	0	0
British	56	10	0	57	0	0

Lead.

Soft Foreign (net)	29	10	0	28	10	0
English			—		Nom.	

Antimony.

Regulus			—	85	0	0

Aluminium.

Virgin Metal 98/99% per ton — —

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots	—

CASTINGS.	Per lb.
I. or II.	—
III. IV. o V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. £50 above price of best selected copper.

15 per cent. Phosphor Copper .. £70 above price B.S.

Phosphor Tin (5 per cent.) .. £30 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAIRLEY STREET MILLS, BIRMINGHAM).

*Chromium (Metallic).

98/99% purity, per lb. — —

*Nickel.

In cubes, 98/99% purity Per ton —

Nickel Silver.

	per lb.
Ingots for raising	—
Ingots for Spoons and Forks	—
" rolled to spoon size	—

*Tungsten Metal Powder.

98/99% purity per lb. —

*Molybdenum Metal.

98/99% purity per lb. —

*Cobalt Metal.

97% purity per lb. —

Quicksilver.

75 lb. bottle —

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting	—		—	
Iron scrap cast (cupola metal)	—		—	

London (f.o.b.).

Heavy steel			105	0
Light "			55	0
Heavy cast			95	0

Control Prices.

Heavy Steel Melting Scrap	105	0	125	0
Steel Planings, Turnings and Borings	65	0		
Steel Planings, Turnings and Borings mixed with Wrought Iron, &c.	50	0		
Steel Scrap, all other Classes	95	0		
Wrought Iron Scrap			125	0
Ditto, mixed with Steel	95	0		
W.I. Planings, Turnings and Borings mixed with Steel, &c.	50	0		

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap	—		
Hy. Selected Scrap Brass	—		
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap	—		
Re-melted Ingot Lead	—		

Stocks.

Metals.

	Tons.
Copper, Europe and afloat	—
Tin, London, Holland, U.S.A. and afloat	—

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	37	6	—	
Foundry	45	0	—	

Glasgow.

Foundry Coke	—		45	0
Furnace Coke	35	0	—	
Gas Coke	—			

London.

Welsh or Durham Foundry, d/d London Stations in truck	45	0	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6		

CONTROL PRICES OF COKE.

	s.	d.
Durham and Northumberland blast furnace	33	6
" foundry	38	0
Yorkshire, Lancashire, Staffordshire, Notts., Derbyshire, Lincs., & Midland Counties blast furnace	32	0
South Wales blast furnace	37	6
" foundry	50	6

All per ton net. f.o.t. ovens.

Cumberland blast furnace	37	9
d/d West Coast furnaces		

SITUATIONS VACANT AND WANTED.

MOULDERS (6) and CORE MAKERS (2) wanted in Brass Foundry, London.—Apply to Box 918, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

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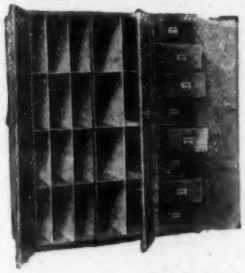

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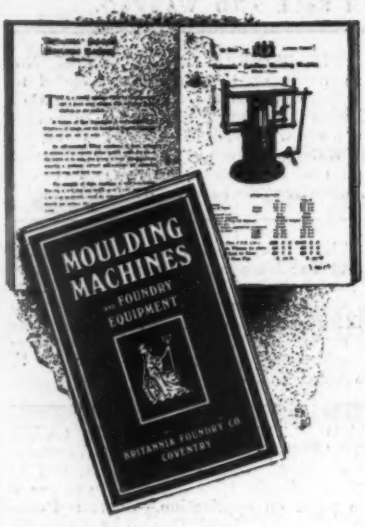

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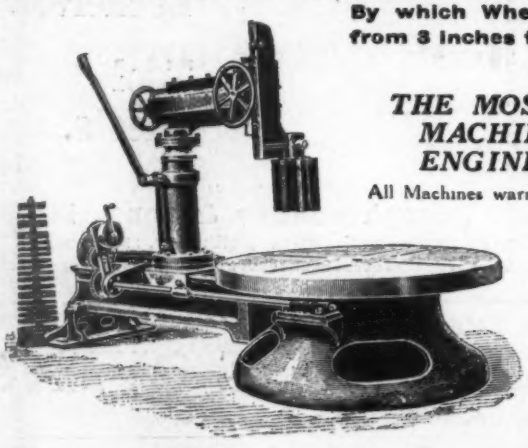

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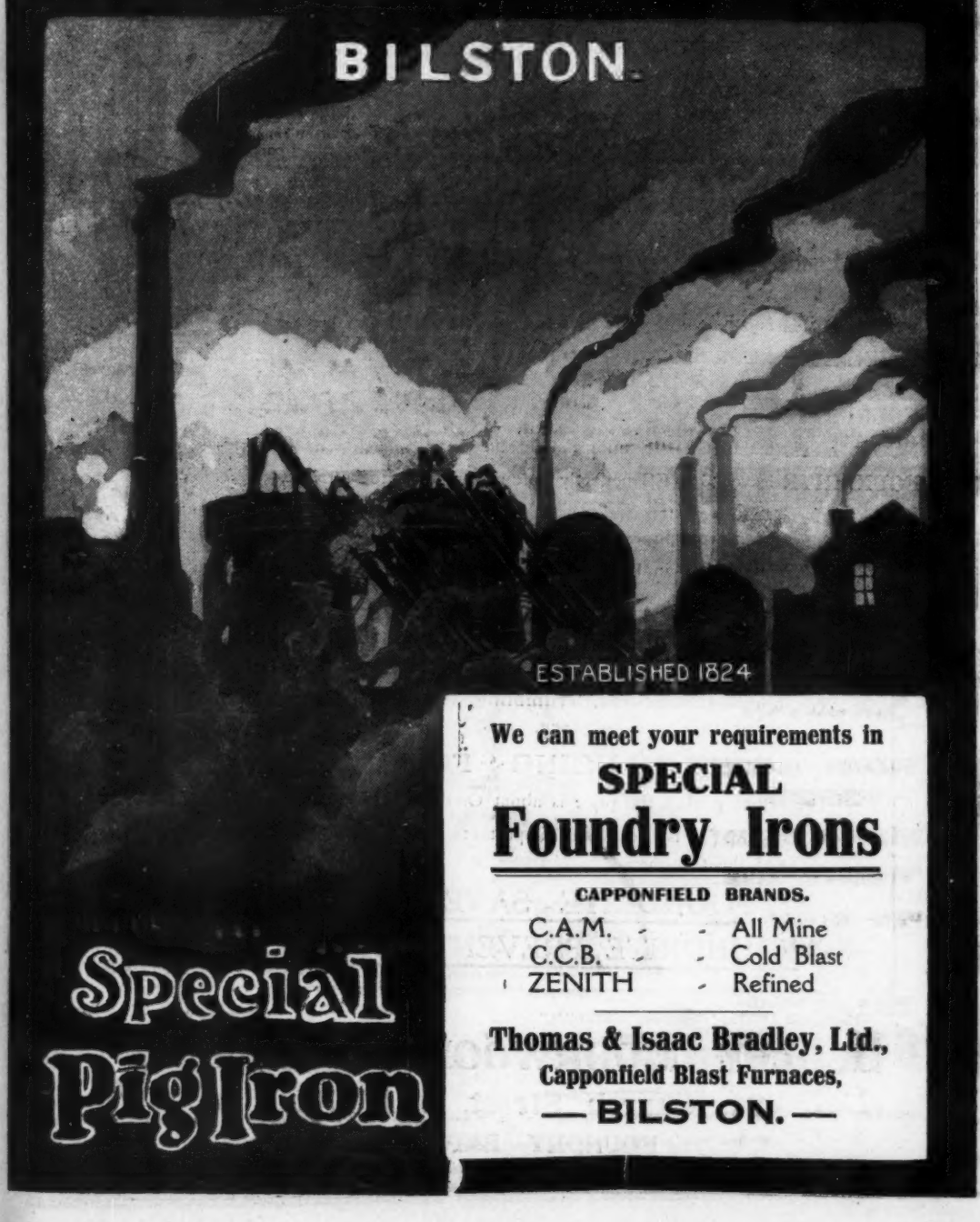

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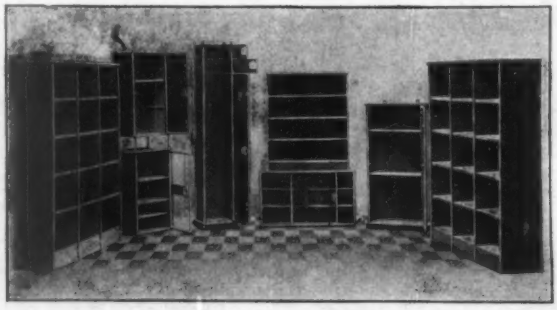

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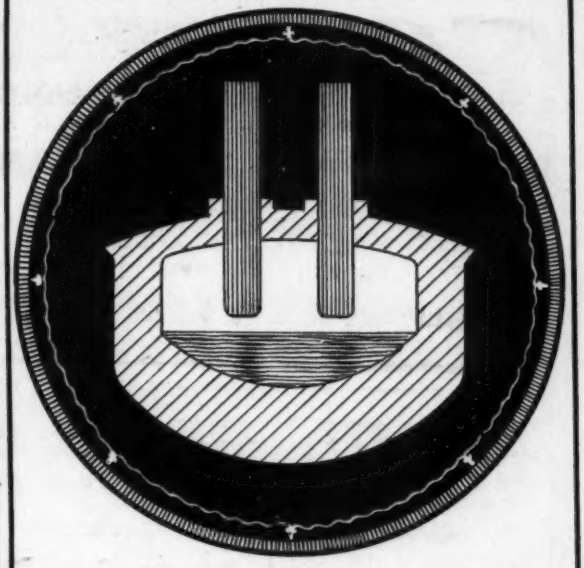

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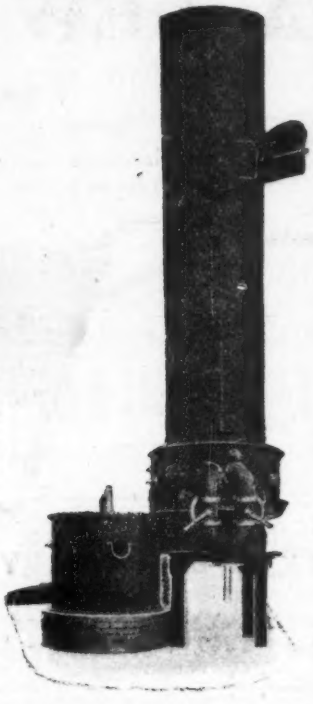

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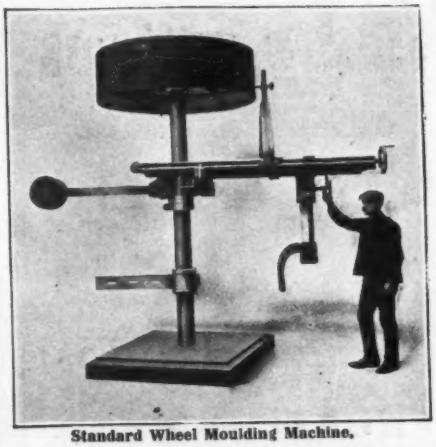

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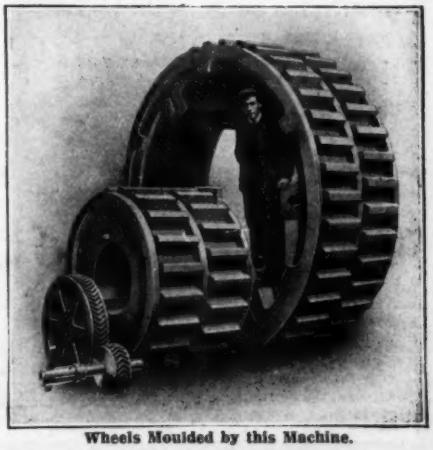

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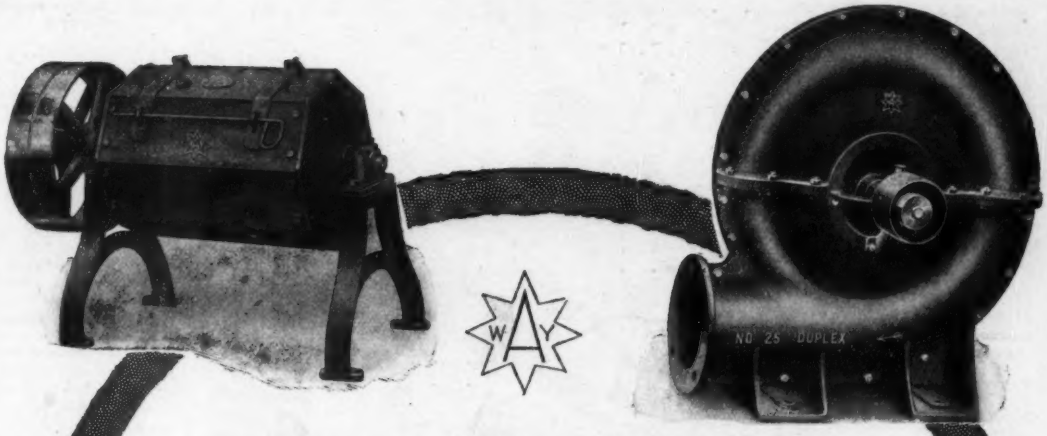

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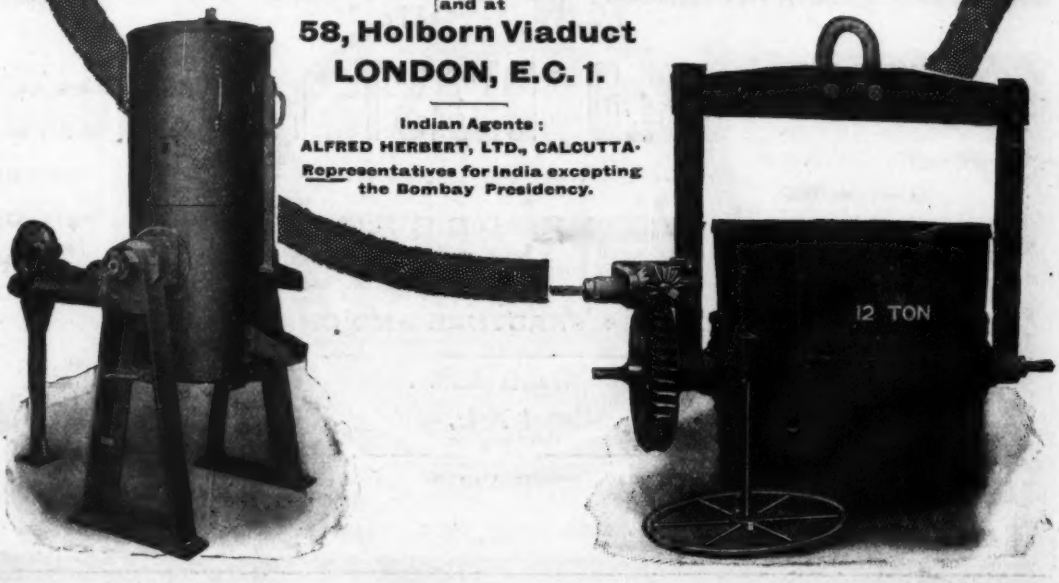

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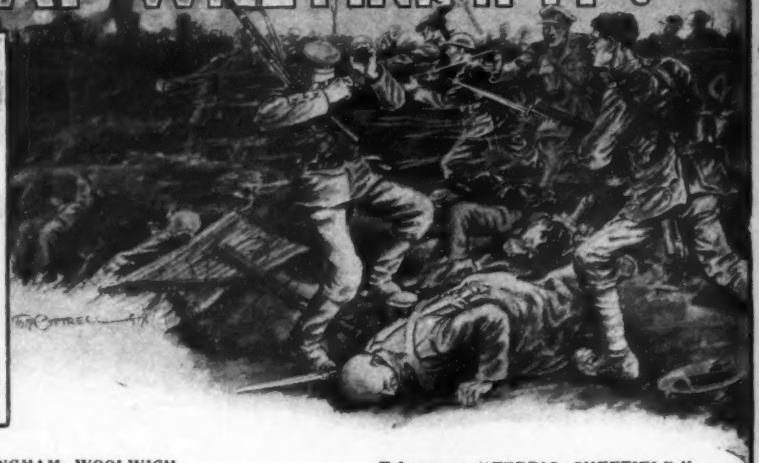

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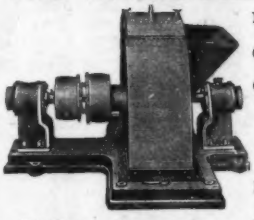

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